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THE JOY OF LIFE

This number of the Journal is dedicated to Agnes Hunt, the " Florence Nightingale of orthopaedic nursing," whose recent death, at the age of eighty-one, marks the conclusion of an era of British surgery characterised by the work of three great leaders: a pioneer of somewhat forbidding austerity—Hugh Owen Thomas; a humanitarian of cheerful benignity—Robert Jones; and a crippled nurse of good humoured determination—Agnes Hunt. It has often been said that Robert Jones' greatest contribution to surgery was that he made acceptable the teachings of Hugh Owen Thomas whose austere and sometimes harsh criticism made enemies where he should have made friends, and who could not himself gain general acceptance of the surgical principles in which both he and his nephew believed. Why did Robert Jones succeed where Thomas had failed? Why was it possible for Agnes Hunt to build a great orthopaedic hospital, create a system of after-care clinics, and establish a new principle of training and resettlement of the disabled? What was it that Robert Jones shared so closely with Agnes Hunt whose personality was in many respects similar to his own? It might have been that diplomacy and tact were coupled with supreme integrity of purpose; or that Robert Jones spoke ill of no man so that all knew they could trust him absolutely. It might have been that both he and Agnes Hunt recognised merit not only in their equals but in their juniors, and having once recognised it gave encouragement, with complete disregard for personal feelings of jealousy. These qualities they shared; but there was more. All who knew Robert Jones will remember the twinkle in his eye; all who knew Agnes Hunt will remember the twinkle in her eye; each had a keen sense of humour, a puckish wit, and an almost child-like pleasure in the simple fun of playing pranks. Incidents in the life of Robert Jones which he delighted to recount in those too short intervals between dinner and the early hour of his retirement reflected the irrepressibility of a boyish sense of fun which he indulged, no matter whether in the consulting room, the council chamber, or the Royal palace, where others might have hesitated lest their behaviour had been considered undignified. Neither Robert Jones nor Agnes Hunt believed that dignity was to be sought by rigid discipline of behaviour; yet each achieved supreme dignity. They believed in the joy of life and they believed in showing it; and it is certain that without these qualities their brilliant success in the treatment of a patient, the organisation of a hospital, or the establishment of a great reform, could never have been achieved. Let us therefore not be ashamed of occasional frivolity, a sense of humour, and simple child-like pleasure; and neither let us be ashamed of showing it in our behaviour, our speech, and even in our writing.

ROBERT JONES AND AGNES HUNT ORTHOPAEDIC HOSPITAL

An appreciation of the life of Dame Agnes Hunt which is published in this number of the Journal makes reference to the Shropshire Orthopaedic Hospital, the title of which was changed to the Robert Jones and Agnes Hunt Orthopaedic Hospital in order to perpetuate the memory and ideals of its first surgical director and its founder. This hospital has a traditional background of its own. More than that, it differs in one fundamental respect from other important orthopaedic hospitals. The difference lies not in the fact that selected patients may still be drawn from distant areas—the Midlands, Westmorland, Cumberland,

Yorkshire, every county in Wales, and the Home Counties in the South, but that from its very inception until this day members of the staff of surgical consultants have travelled from distant University centres and cities—Liverpool, Birmingham, Cardiff, Shrewsbury, Chester, Manchester, and London; and that, as might be expected from a visiting staff of such national distribution, the resident surgical staff has been of international distribution including a high proportion of young surgeons from Australia, South Africa, Canada, and the United States of America. It is easy to suggest that with so widely distributed a staff the hospital is less neat and tidy in its plan than is the usual regional hospital, under a single director, attended only by surgeons who live in close proximity. But in a day when central planning may lead to increasing uniformity it is wise to preserve the individuality which is known to have been the wish of its founder and of its first and greatest surgical director. Long may this hospital continue to be served by distinguished orthopaedic surgeons from all the great cities of the country. The inspiration of a hospital service which is stimulated from many sources is not to be measured in terms of a tidy plan, and though dissemination of the influences brought to bear upon it may perhaps involve some loss, there can be no possible doubt that it confers greater gain. The Robert Jones and Agnes Hunt Hospital stands far above the boundaries of any region; it is a national and indeed an international hospital.

POST-GRADUATE ORTHOPAEDIC TRAINING

One other orthopaedic hospital in this country, also with a long history and with special traditions of its own, has turned to the problem of post-graduate training and the reception of surgeons from overseas—the Royal National Orthopaedic Hospital, London, with its Institute of Orthopaedics which is part of the British Post-graduate Medical Federation of the University of London. This hospital, and the Robert Jones and Agnes Hunt Orthopaedic Hospital, with the post-graduate orthopaedic centre of the University of Liverpool, and all the important orthopaedic centres of the country, supported by the British Orthopaedic Association, is planning co-ordination in the training of orthopaedic surgeons from Britain, the Dominions, and other countries overseas. A first meeting was held a few weeks ago in the Royal College of Surgeons of England which has conferred its blessing and granted the weight of its authority and tradition. It is hoped that by such co-ordination the training of young orthopaedic surgeons will be enhanced in so far as the stimulus of more than one orthopaedic centre will be gained; and that surgeons from overseas will be given the opportunity of experiencing a broad cross-section of the orthopaedic practice of the country.

INTERNATIONAL MEETINGS

The fourth congress of the International Society of Orthopaedic and Traumatic Surgery was held recently in Amsterdam. As a social occasion the meeting was so great a success as to warrant the belief that such gatherings are justified if for no other reason than that the surgeons of many countries may meet and learn to known each other. As an international scientific congress the success of the meeting was perhaps open to doubt. On one day there were forty-two papers, each with a ten-minute limit. One correspondent writes: "Many speakers had much more than twenty minutes' material to present within the ten-minute limit and they were determined to beat the red light. They spoke at three times the normal rate and few of us understood a word." If these meetings are to be regarded as no more than social occasions we must apply ourselves to the language problem, which has been solved at international political conferences and can surely be solved at international scientific meetings. Incidentally, if the International Society of Orthopaedic and Traumatic Surgery is to command the respect and allegiance of democratic countries it must publish its constitution so that we may know how representatives and delegates are appointed.

EDITOR.

ISCHAEMIC NECROSIS OF THE ANTERIOR TIBIAL MUSCLES DUE TO FATIGUE

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Ischaemic necrosis of the lower limb muscles is well recognised as a complication of injury and recorded cases show that, as in the upper extremity, isolated muscles or muscle groups may be affected (Bruce 1940, Parkes 1945, Wood Power 1945). Traumatic ischaemic necrosis of the anterior tibial group of muscles may thus occur; but it is less widely appreciated that such necrosis may also arise when there has been no injury at all.

Hill and Brooks (1936) described muscle contractures arising spontaneously in patients suffering from haemophilia, but it is uncertain whether any of these were due to ischaemic muscle necrosis. Horn (1945) recorded two cases of contracture of the tibialis anterior and the long extensors of the toes in young healthy soldiers after strenuous exercise, and he quoted Vogt as having recognised the syndrome in soldiers after marching. This relationship between exercise and circulatory disturbances of the anterior tibial muscles was stressed by Sirbu, Murphy, and White (1944), who described the case of a young soldier in whom ischaemia of the anterior tibial group of muscles was believed to have been attributable directly to route-marching. Mr J. C. Scott of Oxford tells me that he has knowledge of four such cases, occurring in healthy young adults after strenuous and unaccustomed activity. There can be little doubt, however, that many cases have passed unrecognised, particularly in the acute phase, and this is borne out by the cases now reported.

CASE REPORTS

Case 1. Sergeant C. *History*—On September 13, 1945, after playing football, he felt that his "right knee was somewhat stiff." During the game he had experienced no cramp or pain in the leg and suffered no injury. He had not played football for several months before this game, but his health had been perfect and there had been no previous symptoms. The next day he complained of pain in the whole of the right lower leg and he was reluctant to move the ankle joint. A surgeon diagnosed acute tenosynovitis of the tibialis anterior and applied a viscopaste bandage. The next day the patient reported sick; the pain was unabated, and he was admitted to hospital.

Clinical examination—The patient was a healthy young adult, twenty-three years of age, and he showed these clinical features: 1) swelling of moderate degree over the antero-lateral aspect of the right lower leg as far as the ankle; 2) tense glossy redness of the skin over the middle third of the anterior tibial compartment; 3) extreme tenderness and induration of the whole of the anterior tibial compartment, with a little tenderness over the tibialis anterior at the ankle joint; 4) absolute reluctance to perform any active movement of the ankle joint, due presumably to pain. There was no pallor or cyanosis of the toes, no sensory loss, and no evidence of cardio-vascular or other systemic disease. The temperature was 99·2° F.; the blood sedimentation rate was 28 mm. in the first hour (Westergren); the total white cell count was 11,600 per cu. mm.

A diagnosis of cellulitis was made and the limb was immobilised in a Thomas' bed knee splint. The pain and discomfort settled gradually and by September 29 the tenderness, swelling, and redness had disappeared, but there was still slight evening pyrexia; the blood sedimentation rate was 14 mm. in the first hour. At no time did radiographic examination show evidence of bone injury or disease. Examination on October 4 showed that the muscle belly of the tibialis anterior was abnormally hard, from a level two inches below the tibial tubercle to the junction of the middle and lower two-thirds of the leg. The other muscles of the anterior tibial group were not quite so hard. Active extension of the ankle joint was limited just below the right angle and it was weak. Plantar-flexion was restricted by contracture of the tibialis anterior and to a lesser extent by contracture of the long extensors of the toes. The peroneal muscles were acting normally. There were no vascular or sensory changes in the foot.

Biopsy—October 11, twenty-eight days after the onset of symptoms. The deep fascia of the anterior tibial compartment, and the muscle sheaths, were fused into one thick sheet. Incision revealed that the muscle was pale pink-grey in colour, hard, and without contractile response to mechanical stimulation.

There was little response to direct galvanic stimulation, and no response to strong faradism. It was noted that there was venous oozing from the affected group of muscles. Part of the tibialis anterior muscle was taken for section, and also, for purposes of comparison, a small piece of the gastrocnemius muscle which showed a healthy brick-red colour and was briskly contractile. *Histological examination* of the affected muscle showed gross changes typical of ischaemic necrosis (Fig. 1).

Progress—The patient was fitted with a toe-elevating spring which he wore for five weeks. Follow-up examination in March 1946 showed persistent hardness of muscles in the middle third of the anterior tibial compartment. The total range of active movement of the ankle was 15 degrees. Contracture was maximal in the tibialis anterior and was present to a much less degree in the extensor hallucis longus and the extensor digitorum longus. There were no sensory changes. The patient walked well. His only complaint was of occasional aching in the limb.

Case 2. Leading-Aircraftman S.—A young adult, twenty years of age, had complained of vague pain over the antero-lateral aspect of both lower limbs for nine months. After playing football on May 22, 1946, he noticed dull aching in front of his right lower leg; the whole leg and ankle joint felt stiff. At no time during the game did he experience pain or cramp; nor did he sustain injury. It was not until several hours after the game that symptoms arose. The next day the leg was swollen and very painful and he was admitted to hospital where he received a course of penicillin injections and sulphapyridine, followed later by faradism, radiant heat, and massage. No further details of the clinical condition are available but the treatment which was given suggests that the clinical picture resembled that of an acute inflammatory lesion. After two months he was transferred to another hospital.

Clinical examination—There was: 1) one inch wasting of the right calf; 2) a palpable woody hard area corresponding to the lower two-thirds of the tibialis anterior; 3) limitation of active and passive plantar-flexion at the ankle joint due to contracture of the anterior tibial group of muscles; 4) marked weakness of active dorsiflexion of the ankle joint; 5) no more than a suspicion of active contraction of the tibialis anterior muscle, and a flicker of contraction in the extensor hallucis longus, but good contraction of the extensor digitorum longus and vigorous action in the peronei; 6) diminished sensation over the dorsum of the foot and front of ankle. There was no evidence of vascular impairment in the foot, no swelling, no erythema, no tenderness over the anterior tibial compartment, and no evidence of cardio-vascular or other systemic disease. Radiographic examination of the limb showed no abnormality. The blood sedimentation rate was 2 mm. in the first hour (Westergren). The Wassermann reaction was negative. Electrical reactions showed negligible response to faradism and a weak response to galvanism in all anterior tibial muscles.

Biopsy—September 19, four months after the onset of symptoms, showed that the muscle fibres were yellow-white in colour and very resistant to cutting with a knife. The muscle had undergone mass necrosis and was surrounded by dense cellular fibrous tissue. The summary of the histological report was in the words: " the picture is that of ischaemic necrosis." (Fig. 2.)

Case 3. Leading-Aircraftman H., aged nineteen years, was admitted to the medical wards of a regional hospital on December 15, 1945, with swelling of the neck and face, dysphagia, and weakness of the legs. He gave a history of similar previous attacks, which on the last occasion had been diagnosed as acute thyroiditis. There was no history of injury or of cramp in the legs. While under investigation he developed crops of subcutaneous nodules, blue in colour, varying from $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches in diameter, situated over the chin, thigh, scrotum, forearms, and lower limbs. Each crop of nodules was associated with pyrexia, but blood cultures were negative. *Investigations* showed: blood count—red blood corpuscles, 4·5 million per cu. mm.; haemoglobin, 70 per cent.; white blood count, 9200 per cu. mm.; differential count, no significant change; blood sedimentation rate, 36 mm. in the first hour (Westergren); Wassermann reaction negative; prothrombin time, normal; other investigations, negative. *Biopsy of subcutaneous nodule*—The summary of Professor G. R. Cameron's report on histological examination of one of the nodules is: " Some of the lesions are very similar to the acute stage of periarteritis nodosa but there is not much doubt that a rheumatic infection is the most likely cause of the condition." On February 28, 1946, the patient complained of pain in both feet. The ankles and feet were swollen and there was a large nodule on the right sole. A further crop of nodules appeared, mainly in the limbs, associated with pyrexia of 101° F. After a course of salicylates, the sysmptoms subsided. When he was transferred to an orthopaedic centre he had been getting up for most of the day but he complained of weakness of the lower limbs.

Clinical examination—1) Active and passive plantar-flexion at both ankle joints were limited to 15 degrees by bilateral contractures of the tibialis anterior and extensor hallucis longus; 2) active dorsiflexion was very weak on both sides and was accomplished mainly by the extensor digitorum longus; 3) there was woody hardness over the anterior tibial compartments in both legs; 4) the anterior tibial pulse was not palpable at the ankle joint; 5) there was no sensory disturbance in either leg.

Biopsy of muscles—May 30, 1946. Both anterior tibial groups of muscles were explored. The fascia was thickened and fused with the sheaths of the underlying muscles, the latter being pale, hard, and fibrous, and not reacting to stimulation with the knife. There was faint response to direct faradic and galvanic stimulation. On both sides the tibialis anterior, and to a lesser extent the extensor hallucis longus, were affected; the extensor digitorum communis was involved mildly. Attempted exposure of the anterior tibial artery was made difficult by extensive fibrosis within the compartment. Specimens of the affected muscle and of the normal gastrocnemii were taken for section. *Histological examination* showed changes in the anterior tibial muscles similar to those of Volkmann's ischaemic contracture (Fig. 3). *Progress*—Plaster back slabs were applied at night and toe-elevating springs were used for walking. When last seen the patient was able to get about fairly well.

Comment—The exact nature of the systemic disease in this case is a matter of conjecture. Infarction of the anterior tibial muscles was not recognised so that the precise time of onset, in relation to the general disturbance, remains uncertain. It is possible that this occurred on February 28, 1946, when it was recorded that an attack of pyrexia was associated with pain and swelling of both ankles. However, further questioning, after transfer to an orthopaedic centre, revealed that from the time of onset of the illness the patient had experienced pain in both legs, particularly on the antero-lateral aspect where there was some swelling and redness. That these muscles should be picked out in this way, while the patient was confined to bed, illustrates their peculiar vulnerability to ischaemia even in the absence of physical exercise.

CLINICAL FEATURES

In the acute phase of the condition the clinical picture is sufficiently characteristic to permit accurate diagnosis. It is only failure to bear in mind the possibility of this lesion which accounts for the fact that so many cases pass unrecognised. During the first three or four hours the clinical features resemble those of tenosynovitis of the tibialis anterior, but there is no typical crepitation.

From twelve to twenty-four hours after the onset there is evidence of intense local reactionary inflammation (Lewis 1936). The skin over the anterior tibial compartment, particularly in its lower two-thirds, is tense, glossy, erythematous, and indurated. Swelling may extend as far as the ankle joint. There is often low pyrexia. The blood sedimentation rate shows a marked rise and there may be leucocytosis. It is not surprising, therefore, that most recorded cases were first diagnosed as cellulitis of the leg. Horn (1945) described the onset of pain as sudden and severe, and occurring during exercise. This was not the typical history in the cases here recorded. These patients described a sensation of stiffness over the outer aspect of the shin, and later of aching, gradually mounting to severe pain which reached its greatest intensity from twelve to twenty-four hours later.

Peroneal palsy has been described, but it was not a conspicuous feature in these cases. In Case 1 there was complete loss of voluntary movement at the ankle joint during the acutely painful phase but there was no sensory change. In Case 2 there was a small area of residual hypoalgesia over the dorsum of the foot. The peroneal muscles were not involved. In this respect it is interesting to note that Case 3 was referred to the orthopaedic department because it was thought he had bilateral " drop foot "; in the sense that there was marked weakness of dorsiflexion this was true, but there was no evidence of a peroneal nerve lesion.

In established cases, when inflammatory reaction has been succeeded by replacement fibrosis, the predominant symptom may be " weakness in the legs." There is obvious weakness of active dorsiflexion of the ankle joint, and often of the great toe. Active and passive plantar-flexion at the joint is limited by contracture of the tibialis anterior, and to a lesser degree by contracture of the long extensors of the toes. Palpation of the limb shows typical rigid firmness over the anterior fascial compartment, particularly in its middle third. The anterior tibial pulse may be diminished or absent—a sign which is of doubtful value.

DISCUSSION

Morbid histology—Obstructive vascular lesions in muscle may be of two main types—venous and arterial. In each type the histological picture is characteristic (Brooks 1922, Middleton 1930, Griffiths 1940, Bowden and Guttman 1945). In all cases now under review the microscopic picture showed that they were of the arterial type, similar to that which has been shown by Griffiths (1940) to occur in Volkmann's ischaemic contracture. Islands of necrotic muscle fibres are surrounded by a sea of fibrous tissue. The earlier stages show that the muscle fibres are swollen, enlarged, pale-staining, and with but few sarcolemmal nuclei (Fig. 1). Subsequently they become fragmented and shrunken, and they undergo active phagocytosis by foreign body giant cells (Fig. 4). The appearances after several months are exemplified in Case 2 (Fig. 2): areas of muscle have undergone mass necrosis; while still retaining their structural outlines the fibres exhibit no nuclear staining; closely investing the necrotic muscle is a zone of dense fibrous tissue in which remnants of degenerated muscle fibres persist.

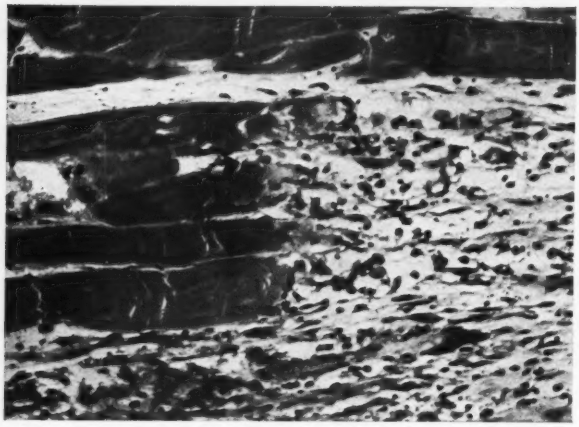

FIG. 1

Case 1. Microphotograph showing peripheral zone of necrotic anterior tibial muscle (×140).

Professor Le Gros Clark (1946) produced identical lesions in the lower two-thirds of the tibialis anterior muscle of rabbits by ligating the main vessels, and demonstrated the remarkable degree of regeneration of muscle fibres which might occur within three weeks, provided that a stump of healthy muscle fibre remained. He showed convincingly that fine strands of protoplasm streamed down the muscle tubes into the necrotic area until, by the end of four months, the whole of the necrotic area was completely replaced by newly regenerated muscle fibres.

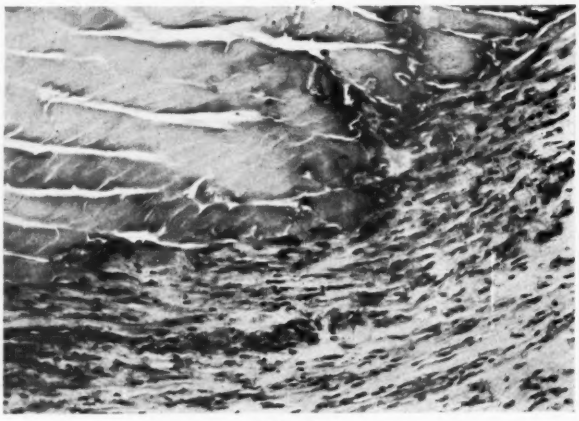

FIG. 2

Case 2. Muscle sequestrum surrounded by mature fibrous tissue; appearance four months after onset (×100).

Regeneration of necrotic muscle in the human being. Figs. 5 and 7 show unmistakably that such regeneration can occur also in human muscle. When asked for his opinion on these sections, Le Gros Clark pointed out that the difficulty in regeneration of human muscle, as compared with the muscle of rabbits, arose from its bulk; after ischaemic necrosis

extensive fibrosis occurred before the regenerating fibres had time to cover the ground. Sprouting fibres soon met with the obstruction of fibrous tissue and became dammed up into large blobs of multinucleated protoplasm. These are shown typically in Fig. 5.

The possibility of primary arterial disease causing ischaemic necrosis of muscles—In view of the suggestion confidently put forward by Horn (1945) that chronic arterial disease preceded muscle necrosis, careful study was made of these sections by which to substantiate or refute this view. Two changes may be seen in the vessels included in the sections: first, there is thickening of the media, associated with a narrow lumen; second, there is diffuse perivascular cellular infiltration. One large vessel in Case 1 showed generalised intimal thickening. The clinical features in Case 3 suggested that arterial disease such as periarteritis nodosa might have been responsible for the infarction, but there was no histological confirmation.

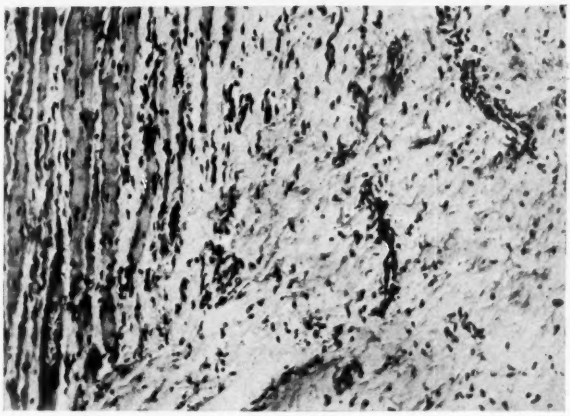

FIG. 3

Case 3. Replacement of muscle by dense fibrous tissue (× 100). The changes are exactly similar to those in Volkmann's ischaemic contracture.

The vascular abnormalities we have found can be explained fully as secondary changes. Death of functional muscle, and its replacement by avascular fibrous tissue, greatly reduces the vascular bed to be supplied. Small vessels naturally undergo involutionary thickening with narrowing of their lumina. Similar involutionary changes are known to occur in the uterine vessels after parturition, and in the umbilical cord after birth. Furthermore, with so much tissue necrosis, much of the cellular infiltration will be approximated to the vessels. It is of course recognised that sections of muscle tissue seldom contain larger vessels; but even the illustration of the anterior tibial vessels in Horn's article does not offer convincing evidence of primary arterial disease. The biopsy was taken sixteen days after the onset of necrosis; the lumen of the artery was narrowed; the media was obviously thickened; and both artery and vein were matted together in fibrous tissue. The artery at operation was found to be surrounded at one level by a mass of firm grey tissue. These changes might well have been secondary

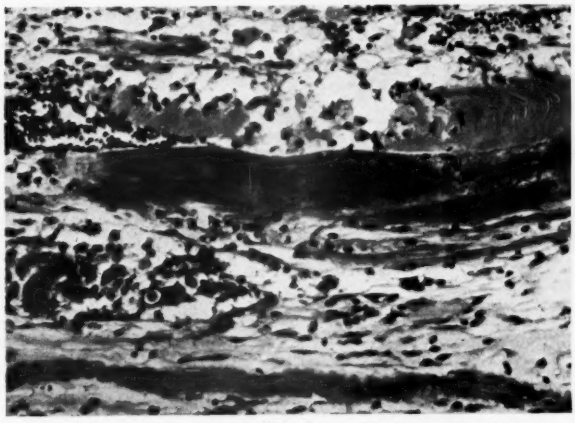

FIG. 4

Necrotic fibres after twenty-one days; fragmentation, phagocytosis by giant cells, replacement by delicate fibrous tissue; note persistent cross striations (× 175).

to involvement of the vessels in the dense mass of fibrous tissue which had formed by that time. Summarising, I do not think there is anything in the histological picture which can be regarded as the cause of the muscle damage.

Pathogenesis—Study of the morbid anatomy in these cases indicates that necrosis and contracture of the muscles is the result of acute arterial insufficiency. It is well known that, in advanced arteriosclerosis of a limb in which there is peripheral gangrene, there may be complete occlusion of the femoral artery in the adductor canal and yet no more than moderate atrophy of the muscles below the knee. Occlusion of the main artery of supply will not, alone, cause muscle necrosis; the occlusion must occur rapidly and it must be maintained

FIG. 5

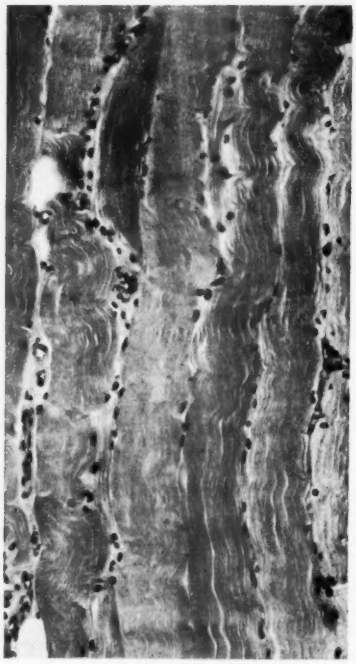

FIG. 6

Fig. 5 shows regenerating fibres of the anterior tibial muscle after necrosis in Case 1. Note the size, the nuclei, and the terminal blobs (×280). Fig. 6 is a section from the normal gastrocnemius in the same case (×150).

for six to twenty-four hours (Lewis 1936, Cohen 1944). Such a state could, theoretically, be brought about by extraluminary occlusion (mechanical compression or kinking) or by intraluminary occlusion (embolism, thrombosis, or spasm). Until the nature and anatomical level of such occlusion can be deduced, pathogenesis must be a matter of speculation.

Anatomical considerations in relation to vulnerability of the anterior tibial group of muscles—We may wonder why it is that the anterior tibial muscles should be so susceptible to infarction. It is not entirely a question of special demands during activity, for Case 3 illustrated bilateral involvement while the patient was confined to bed. Nor is it simple coincidence that the tibialis anterior muscle should bear the brunt of the attack, while the extensor digitorum longus muscle often escapes so lightly; it is the logical sequence of their vascular pattern.

Blood supply of the anterior tibial muscles—Campbell and Pennefather (1919), in an excellent paper, showed that intramuscular anastomoses were so fine that the main muscular branches could be regarded functionally as end-arteries. More recently the vascular pattern of individual muscles has been worked out carefully by Blomfield (1948) using radio-opaque injection media. I am greatly indebted to him for detailed observations on the blood supply

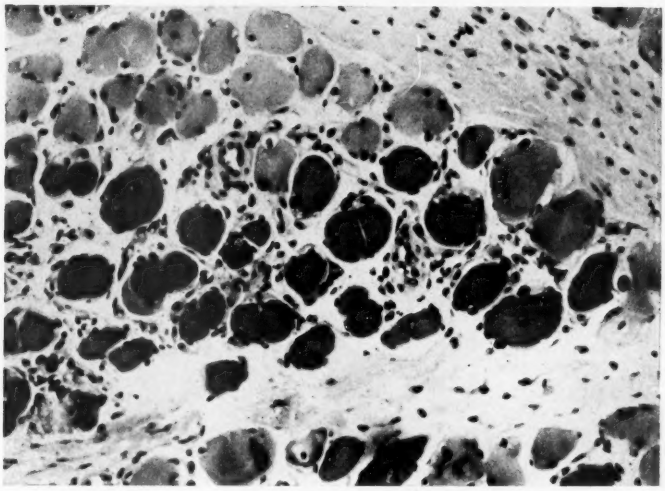

FIG. 7

FIG. 8

Fig. 7 is transverse section of the regenerating muscle fibres in Case 1. Note the endomysial proliferation and variation in size. Fig. 8 is a transverse section of the normal gastrocnemius (×260).

of the anterior tibial muscles, much of which is still unpublished. The major blood supply of muscles of the anterior tibial compartment * is from the anterior tibial artery, which emerges between the two heads of the tibialis posterior muscle. Vogt (1943) suggested that the vessels might be injured by sliding contact with the edge of the interosseous membrane.

* The term anterior tibial compartment refers to that fascial compartment containing the tibialis anterior and the two long extensors of the toes.

This has not been substantiated in my anatomical dissections which indicated that as the vessels pass forwards they are surrounded by a cuff of loose areolar tissue and are cushioned by muscular fibres, the free edge of the interosseous membrane being situated at least one to two centimetres distally.

The tibialis anterior muscle is supplied almost entirely by the anterior tibial artery through a series of segmental branches, approximately twelve in number, which divide into ascending and descending divisions anastomosing by a system of arcades (Le Gros

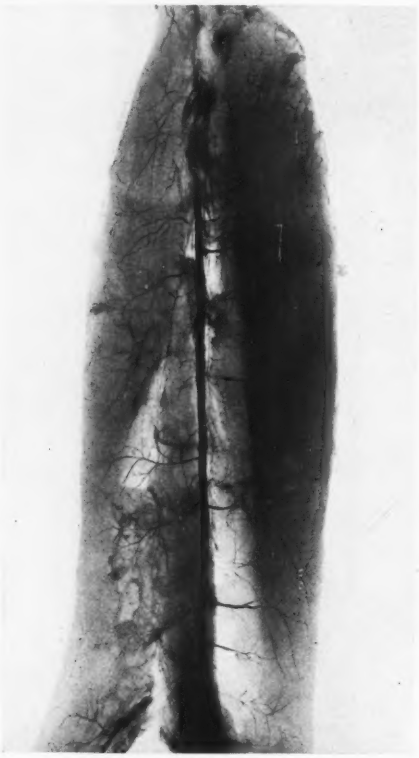

FIG. 9

Cadaveric injection showing the normal vascular pattern of the anterior tibial muscles in a patient aged twenty-three years. The tibialis anterior is to the right. Radio-opaque suspension was injected into the femoral artery, and the anterior tibial muscles then removed *en bloc*.

FIG. 10

Vascular pattern of the left anterior tibial muscles; injection into femoral artery after ligation of the anterior tibial artery at the level of its recurrent tibial branch. Note retrograde flow. (Patient aged seventy-nine with bilateral Paget's disease of the tibiae.)

Clark 1946, Blomfield 1948). The proximal third of the muscle is supplied by a leash from the anterior tibial recurrent artery. My own observations on injected specimens, cleared by Spaltholz' method, tend to confirm the view of Campbell and Pennefather (1919) that intramuscular anastomoses are so fine that their functional significance is open to doubt.

According to Blomfield (1945, 1948) the extensor digitorum longus has a threefold supply: 1) from the anterior tibial artery and its recurrent branch; 2) by three large perforating branches from the posterior tibial artery; and 3) by a large branch to the lower

third of the muscle from the perforating peroneal artery. These branches anastomose throughout the length of the muscle. The extensor hallucis longus has a twofold supply: 1) from the anterior tibial artery; and 2) from the perforating peroneal artery. The intramuscular anastomosis is described as rectangular and of a less efficient type (Le Gros Clark 1946).

Assuming these observations to be correct we should expect that sudden complete occlusion of the anterior tibial artery, as it enters the anterior compartment, would deprive

FIG. 11

Vascular pattern of right anterior tibial muscles (same case as Fig. 10); injection into femoral artery after ligation of anterior tibial artery both proximally and distally (see text). Note partial filling of anterior tibial artery through the perforating branches supplying the toe extensors.

FIG. 12

Incomplete filling of the anterior tibial artery ligated proximally and distally; note very little flow into the muscles. Injection of radio-opaque suspension into the femoral artery after ligating the anterior tibial artery both proximally and distally shows incomplete filling of the main vessel and very little flow into the muscles.

the tibialis anterior of its entire blood supply and result in total necrosis. The extensor digitorum longus and extensor hallucis longus, on the other hand, having an additional blood supply from perforating arteries, might be expected to escape more lightly, the greater involvement of the long extensor of the big toe being explained by its relatively poor anastomotic network within the muscle.

It will be remembered that in two cases the clinical findings suggested that the proximal third of the muscle bellies was affected minimally. The inference to be drawn, I think, is

that occlusion of the anterior tibial artery probably occurred distal to its tibial recurrent leash; this was certainly so in the only recorded case in which the artery was seen (Case 2).

The extreme rarity with which there is gangrene or necrosis of the peroneal muscles is accounted for by the extensive blood supply which they receive from the peroneal artery.

Tension within the fascial compartment—Much stress has been laid on the rigidity of the walls of the anterior tibial compartment and the resulting vulnerability of its contents to circulatory disturbances. Little point has been made of the fact that this fascial space is not closed at its lower end. Blomfield quoted a case reported by Zachary in which ischaemia of the anterior tibial muscles was said to have occurred after severe swelling within the fascial space. Others have been mentioned after direct blows and haematoma formation.

Lewis (1936) showed that much lower pressures than were required to collapse the main artery might result in complete arrest of the blood flow when applied directly to the muscle. Thus pressures of 50 to 60 mm. Hg., applied directly to the muscle and maintained for twenty-four hours, might produce necrosis, whilst in animal experiments the same results were produced within six to ten hours. Prolonged activity of a muscle may increase its weight by 20 per cent., the bulk being increased by the retention of excessive fluid within the tissue spaces (Wright 1936). If for this, or any other teason, tension within the fascial compartment rises, the circulation within the intramuscular vascular networks must be embarrassed. But it must be assumed that such tension, being within a confined space, will be distributed uniformly and that all branches of the network, whether arising from the anterior tibial artery or from perforating branches, will be affected equally. On the other hand, raised pressure sufficient to obliterate the main vessel against an unyielding interosseous membrane would be more than enough to obliterate all intramuscular capillaries and give rise to uniform necrosis of all these muscles.

Sirbu, Murphy, and White (1944) described an example of ischaemic necrosis occurring five days after repair of a small hernia of the anterior tibial muscles. In such a case it is difficult to avoid the conclusion that tension played some part. The writers themselves suggested that it may have initiated arterial spasm. Nevertheless, if increased tension within the fascial compartment was the main factor in producing spontaneous ischaemic necrosis, it would be difficult to explain the susceptibility of individual muscles of the anterior tibial group, or the tendency for the proximal third of the tibialis anterior to escape.

Intraluminary vascular obstruction—The possibility of extraluminary occlusion, both in relation to the main artery and to the finer anastomotic branches, has already been discussed. It remains to consider embolism, thrombosis, and arterial spasm, as the possible causes of intraluminary obstruction. In none of the recorded cases has cardiac disease or other source of embolism been demonstrated. Furthermore, the anterior tibial artery arises from the popliteal trunk almost at a right angle, an anatomical feature which would not favour lodgement of an embolus. Learmonth (1944) described localised thrombosis of indeterminate origin affecting the main arteries of the limb, but his cases were of gradual onset and they bore little resemblance to the cases under consideration.

The evidence in favour of underlying primary arterial disease, with or without thrombosis, is not convincing. At this age, thromboangitis obliterans and periarteritis nodosa are the two most likely conditions, the former being more likely to affect vessels of the calibre of the anterior tibial artery and to occur unilaterally. Indeed Professor G. R. Cameron, in a personal communication, subscribed to this view. Case 3 in this series presented many of the clinical and histological features of periarteritis nodosa. But this disease affects the smaller vessels, and in order to produce the widespread necrosis which was observed, it would necessarily have involved most of the segmental muscular branches of the anterior tibial artery—which was not the case in any of the sections examined. In two recorded cases there was a history of previous aching in the anterior tibial region for some months, but apart from this there

had been no symptom suggestive of underlying vascular disease. If the main vessel or its muscular branches were obliterated, one would have expected that muscle cramp or pain would have occurred during strenuous exercise, as a premonitory symptom before the onset of ischaemic necrosis.

INVESTIGATIONS ON CADAVERS AS TO THE VASCULAR PATTERN OF THE ANTERIOR TIBIAL MUSCLES

Investigations were carried out with the object of establishing the effect of arterial occlusion on the vascular pattern of the anterior tibial muscles. 1) Controls of the normal pattern were made by injecting radio-opaque suspensions, of the same viscosity as blood, into the femoral artery at a pressure of 140–200 mm. Hg. The anterior tibial muscles were removed *en masse*; their separate portions were defined and X-rayed. The muscles were then cleared, using Spaltholz' method, and the findings were confirmed (Fig. 9). 2) Adopting the same technique, injections were made into the femoral artery after ligating and dividing the anterior tibial artery at the level of the anterior tibial recurrent branch. 3) The same procedure was carried out after ligating and dividing not only the anterior tibial artery at its anterior tibial recurrent branch, but also the artery two inches proximal to the ankle joint. 4) Injections were made after ligation and division of both anterior and posterior tibial arteries, thus completely cutting off the blood supply of all three muscles. 5) The anterior tibial muscles were carefully removed in one piece together with the anterior tibial artery; the artery was then injected with a radio-opaque suspension after first ligating it one and a half inches below the point of injection. The procedure was repeated at distances of three inches, four and a half inches, and six inches distal to the point of original injection (Fig. 13).

Findings—The vascular patterns of these muscles varied with age, and they varied in different individuals. The older the subject the finer, and the more tortuous, was the intramuscular network. One subject, aged seventy-nine years, who had Paget's disease of both tibiae, exhibited a particularly generous vascular network.

Certain facts were established. 1) Occlusion of the anterior tibial artery as it enters the anterior fascial compartment does not deprive the muscles of their entire blood supply; there is often a retrograde flow from below, which is distributed to the three muscles it supplies (Fig. 10). 2) Ligation of the anterior tibial artery proximally, and also distally in order to cut off the retrograde flow, still results in seeping of blood into the intervening arterial segment which is, however, insufficient to be redistributed in significant degree to the tibialis anterior. This incomplete filling must occur through the perforating branches which pierce the extensors of the toes and sometimes effect almost direct communication with the anterior tibial trunk. The extent of the alternative supply appears to be variable. In some it is considerable and no doubt sufficient to maintain viability of the toe extensors (Fig. 11). In others, although partly filling the anterior tibial trunk, it contributes little to any of the muscles (Fig. 12). 3) Injections of the anterior tibial artery after ligation at successive levels confirms the segmental vascular arrangement and suggests that the longitudinal arcade anastomosis may not have much functional significance (Fig. 13A, B, C).

The critical level of obstruction of blood flow which causes necrosis is not known, but it would seem that a localised complete occlusion of the anterior tibial artery is unlikely to cause necrosis; on the other hand a longer segmental occlusion of the vessel, such as may be produced by arterial spasm, would obliterate the main channel by which retrograde distribution through the segmental branches may be brought about. The alternative blood supply to the two extensors through perforating branches may be sufficient in some cases to preserve their viability but quite apart from this their smaller bulk tends to minimise the degree of contracture which can be detected clinically.

Relationship to exercise—The relationship of exercise to acute ischaemia of the anterior tibial muscles is so striking a feature that it demands consideration. Horn (1945) ingeniously surmised that " hypertrophy and fibrosis of the media of the anterior tibial artery " which he believed to be an essential underlying vascular change, was a result of the repeated and overwhelming demands of muscles during strenuous exercise. He believed that involvement of the adventitia in this fibrosis caused reflex vasoconstriction " affecting the entire collateral network " and that the circulation was further impaired by muscular swelling due to chemical and histological changes as described by Howard (1937) in crepitating tenosynovitis. This hypothesis does not, however, bear critical scrutiny. No artery narrows its lumen in response

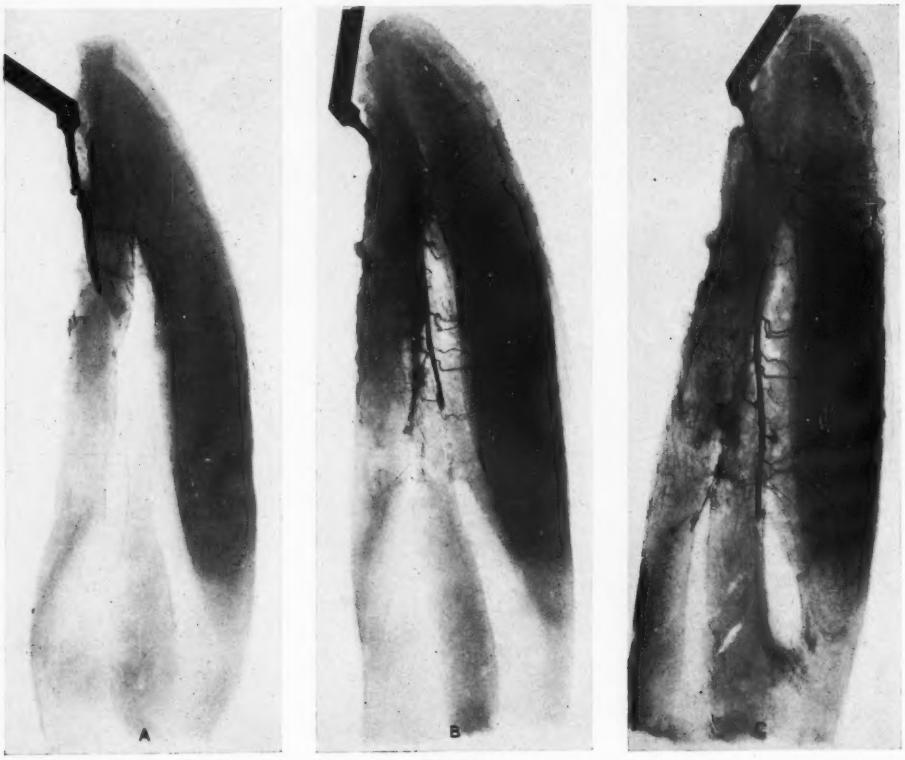

FIG. 13

A, B, and C show the vascular pattern after ligation of the anterior tibial artery 1½ inches, 3 inches and 4½ inches respectively, from the point of injection (see text); note the segmental nature of the blood supply.

to increased demands by the area it supplies. The normal vascular response to muscular activity is one of diminished peripheral resistance with an increased capillary bed. There is no hypertrophy of the media; such a change, if it occurred, would be more in keeping with prolonged arterial spasm. Secondly, the tibialis anterior has no collateral blood supply other than its segmental branches, and even in those muscles which have an alternative supply the intramuscular networks are probably under humoral rather than autonomic control. Thus spasm, even if segmental, does not presuppose involvement of a collateral field in order to produce complete ischaemia.

Whatever condition may be responsible for acute ischaemia it must have persisted for six

to twenty-four hours in order to produce necrosis (Lewis 1936, Cohen 1944), and there is clinical evidence that the resulting inflammatory reaction occurs about twelve to twenty-four hours after the strenuous exercise, suggesting that vascular insufficiency began during the physical effort, or probably shortly after it. In Case 1 and Case 2 in this series the onset appears to have been after exercise; on the other hand Horn's cases suggest onset during the exercise.

It may be urged that complete vascular occlusion need not be assumed, and that the ischaemia is relative rather than absolute. Demands upon the vascular supply may be in excess of that which it can provide, for the metabolism of muscle in activity is greatly increased, and if exercise is more strenuous than is customary for the individual, the power of oxygen abstraction is appreciably diminished (Wright 1936). The muscle is subjected to relative anoxia and necrosis supervenes. The analogy to this would be the ischaemic limb in which gangrene is precipitated by increasing the metabolic demands of its tissues. Such a view is hardly tenable when one realises that in order to produce muscle necrosis the oxygen deprivation would have to persist much longer than the period of muscular exercise to which the patients were subjected. Nevertheless, I think that relative anoxia during strenuous and unaccustomed exercise is probably an important secondary factor in tipping the scales in favour of necrosis. The local accumulation of lactic acid, and its coagulative action on muscle fibres as described by Albert and Mitchell (1943), whether it be the result of venous obstruction or of arterial insufficiency, is merely the means by which anoxia effects necrosis.

In the light of present knowledge it seems that the most likely primary cause of spontaneous ischaemia is spasm of a large segment of the anterior tibial artery, beginning just below its anterior tibial recurrent branch. Is it possible that the marked chemical and pH changes which are known to occur in fatigued muscles, and in tenosynovitis, could initiate this spasm? It is known that muscle break-down products in ischaemia, particularly adenosine derivatives, are capable of producing spasm of the renal vessels (Green and Stoner 1945), and it may well be that accumulated metabolites in fatigued muscle are capable of a similar action locally. Tension within the anterior fascial compartment is probably an aggravating factor. Arteriography, or exploration within the first twelve hours after exercise, may provide the answer.

TREATMENT

Advance in our knowledge of curative treatment depends upon early diagnosis. The obvious difficulty lies in the fact that if there is delay, irreversible damage has already been done by the time that inflammatory changes become evident clinically. The object should be to relieve arterial spasm before necrosis supervenes. Early eupaverine injection might be helpful, but the effect of paravertebral block on muscle circulation is still debatable. Assuming that a case is seen within the first twelve hours, exploration appears to be warranted. The operative approach should be between the muscles rather than through them. Care must be taken to avoid damage to intramuscular branches. The fascia cruris should not be repaired. If there is arterial spasm the appropriate treatment should be employed but it must be borne in mind that arteriectomy should be limited to resection of a very small segment; the part of the tibialis anterior muscle which will be deprived permanently of its blood supply is directly proportionate to the length of arterial segment excised. The danger of exploring muscles after necrosis has supervened cannot be over-emphasized. Necrotic tissues are prone to infection and gangrene, and in one case amputation was necessary. (Sirbu *et al.* 1944.)

Whatever treatment may be undertaken during the first twenty-four hours, the limb should be supported with the ankle in the mid-position and free from constriction. This position should be maintained until the acute inflammatory reaction has subsided and until there is no longer any tendency to further contracture. Subsequently a toe-elevating spring should be worn for the first few months of weight-bearing. Surviving muscle fibres should be redeveloped by graduated exercise.

SUMMARY

1. Three cases are reported of ischaemic necrosis of the anterior tibial muscles which were not due to injury. In two, ischaemia was the result of strenuous or unaccustomed exercise in young adults; in the third it was an incident in a systemic disturbance. All three cases were probably the result of spasm of a large segment of the anterior tibial artery.
2. The clinical features during the first few hours resemble those of tenosynovitis of the tibialis anterior; and after twelve to twenty-four hours those of cellulitis of the leg. Later there is " drop foot " due to muscle weakness, contracture limiting plantar-flexion movement, and woody hardness of the muscles in the middle third.
3. The morbid histology is similar to that of Volkmann's ischaemic contracture.
4. The possible explanations—primary arterial disease, arterial occlusion by pressure of the interosseous membrane, occlusion by tension within the fascial space, intraluminary occlusion by embolism or thrombosis, and fatigue arterial spasm, are discussed.
5. The vascular pattern of the anterior tibial muscles has been studied by experimental injections in cadavers.
6. It is concluded that the most likely cause is spasm of the anterior tibial artery due to muscle fatigue, aggravated by increased tension within the anterior fascial compartment due to reaction after strenuous exercise.
7. Treatment is outlined. Exploration of the anterior tibial artery within the first twelve hours is warranted, but late exploration may be dangerous.
8. Although not previously recognised, evidence is shown that regeneration of necrotic muscle is possible in the human being.

I wish to express my thanks to Sir Reginald Watson-Jones for his encouragement, and to him and Mr H. Osmond-Clarke for permission to publish these cases; to Dr Harrison, Professor G. R. Cameron, and Professor Le Gros Clark for their advice on histological material; in particular to Dr Blomfield for access to unpublished work on the vascular pattern of muscles; to Mr R. Tucker, Lady Jones Research Fellow in Liverpool, for injection facilities and for valuable help and criticism; and to Mr John King of the London Hospital to whom I am indebted for the microphotographs.

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DEVELOPMENTAL COXA VARA

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Excellent papers have appeared from time to time on the subject of developmental coxa vara, sometimes under the titles of congenital, infantile, or cervical coxa vara. Despite this fairly extensive literature, and probably because the condition is not common, its real nature and severity have seldom been recognised as soon as they should be, and treatment has not usually been started until there was marked deformity. The condition is characterised by the development, at the age of about three or four years, of a limp or waddle which is usually painless and is progressive. A varying degree of coxa vara deformity is present on one or both sides, but the most striking feature is the radiographic appearance of a gap in the neck of the femur just distal to the epiphyseal line, together with a bend in the femoral neck at this level. This X-ray appearance is, in itself, almost sufficient to establish the diagnosis as soon as the patient is first seen.

Frequency—The condition is rare, and few large series of cases have been reported. Statistics of the Hospital for Sick Children, Toronto, show that in twelve years, 1936 to 1947 inclusive, fifteen patients with developmental coxa vara were admitted. In the same period 197 new patients were admitted with congenital dislocation of the hip joint. Thus we have seen one case of coxa vara for every thirteen cases of congenital dislocation. It is to be noted, however, that congenital dislocation of the hip joint does sometimes run in families and that it is more common in some districts than others. Moreover, developmental coxa vara may also run in families. It is possible, therefore, that in comparing the incidence of developmental coxa vara with that of congenital dislocation of the hip joint our ratio of one to thirteen may be different from that of other clinics.

Familial tendency—This paper is based on fifteen cases admitted to the Children's Hospital, Toronto, and one other case which was first seen at the age of forty-three years. Of these sixteen patients, eight were males and eight were females. In ten, the condition was present on one side; in six, both hips were involved. Of the sixteen patients, four were related: two were brother and sister, and two others were second cousins of these first two. They all had other brothers and sisters, none of whom had any limp. One uncle who was reported to have had a limp could not be traced. None of the other twelve patients were related and none gave any history of a limp in the family.

CLINICAL HISTORY AND PHYSICAL SIGNS OF DEVELOPMENTAL COXA VARA

Clinical history—The clinical history was somewhat the same in all cases. In a few, the limp or waddle was noticed when the child first began to walk, but in most it did not appear until the age of three or four years, the gait being apparently normal before that age. The limp was not preceded by any severe injury and it was usually painless. At first it was very slight, but it increased slowly; as a rule it was not until a year later, and usually much more than a year later, that the patients sought advice. In a few cases, long after the limp had developed, there was a history of a sudden attack of moderate pain, coming on after trivial injury, disappearing in a couple of weeks, but leaving definite and lasting increase in the limp. More commonly the limp increased gradually over a period of six or seven years and remained almost painless throughout. In cases which were first seen at a later age, there was a history of some improvement in the limp at the age of about twelve years. One patient, seen at the age of forty-three years with marked bilateral deformity (Fig. 4), had developed

* *Paper read at the combined meeting of the American, British, and Canadian Orthopaedic Associations, in Quebec, June* 4, 1948.

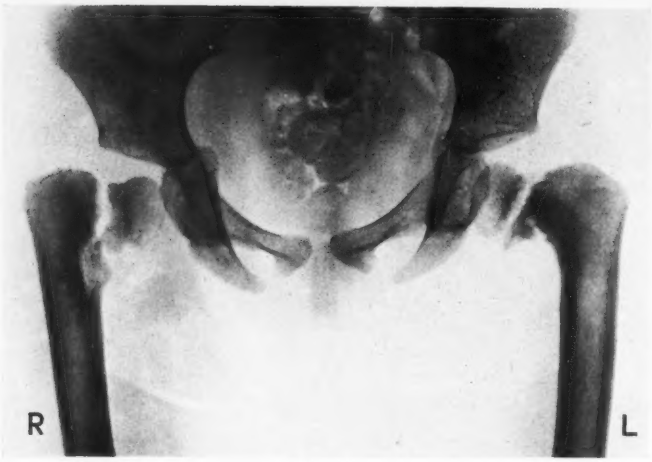

FIG. 1

Developmental coxa vara; age four years. On the right, the gap in the bone branches away from the epiphyseal line at its lower end. On the left, it branches into two, leaving a triangular part of bone separated.

FIG. 2

Bilateral developmental coxa vara first seen at the age of six years, with only slight deformity and with the gap in the bone more horizontal than vertical. The appearance of "fragmentation" is rather marked.

severe pain on one side at the age of forty years, probably because of arthritic changes in the altered hip: the pain was much improved by subtrochanteric osteotomy.

Clinical examination—Physical examination of these patients showed no abnormalities except those which were attributable to the condition of the hips. Most patients were rather short in stature, shorter than other members of the family at the same age, but not to a marked degree. None showed signs of rickets. There was elevation of one or both trochanters with limitation of abduction movement, the degree of limitation depending on the degree of coxa vara deformity. When this deformity was severe, there was also limitation of

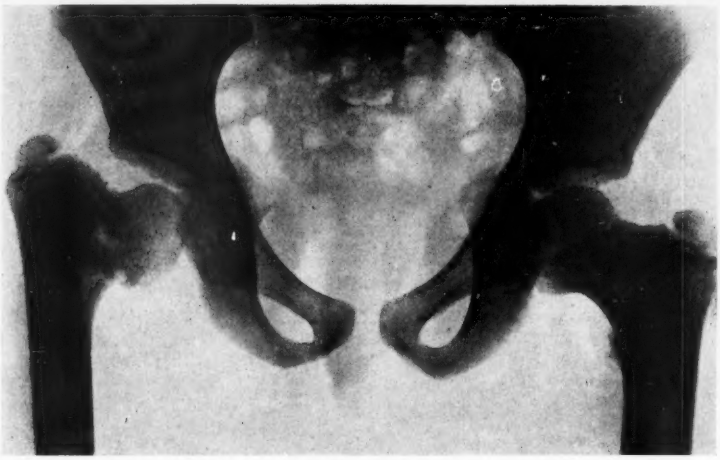

FIG. 3

Developmental coxa vara seen at the age of eight years with rather marked deformity and shortening of neck, particularly at its lower margin, thus giving an impression of collapse of the tissues forming it.

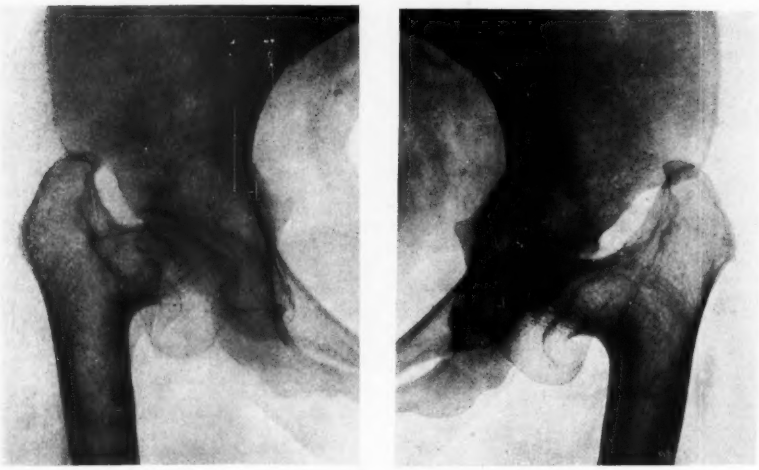

FIG. 4

Developmental coxa vara first seen at the age of forty-three years; no treatment. The gap in the bone has closed, but with marked deformity. The gait was good but there was pain on one side, during the last few years, from secondary arthritis.

extension movement of the hip, and of rotation movement in both directions, but in none was there marked external rotation deformity of the limb such as is seen in slipped epiphysis. In bilateral cases there was moderate lumbar lordosis on standing. The femur below the neck appeared normal and, when only one side was involved, the length of the two limbs as measured from the trochanters was the same.

In early stages the children did not complain of pain, although usually they tired easily. By the time the patient was first seen the limp or waddle was rather marked; it was greater than could be accounted for by deformity alone, and it seemed probable that to some extent

FIG. 5

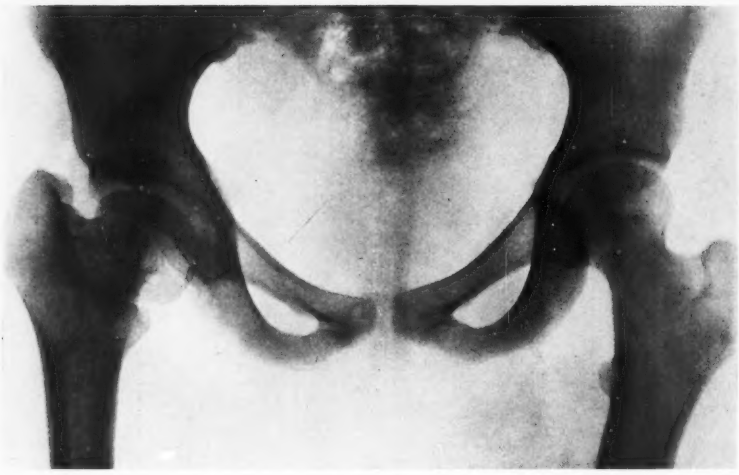

FIG. 6

Developmental coxa vara in a patient who had no treatment. The gap in the bone, shown at the age of twelve years (Fig. 5), closed completely by the age of seventeen years (Fig. 6) with normal looking bone, but with moderate varus deformity and considerable shortening of the neck.

the limp was due to instability of the femoral neck at the gap. In older patients, when the gap in the femoral neck had healed, the gait, having regard to the severe degree of deformity, was extraordinarily good.

Radiographic examination—The radiographic appearances were very similar in nearly all cases. Even in early stages, when the child first began to limp, a gap in the bone was already obvious (Fig. 1). It crossed the neck of the femur distal to the epiphyseal line. In most cases it ran part of its course parallel to the epiphyseal line, but towards one end, usually the lower end, it branched away from it, and in some cases, also usually at the lower

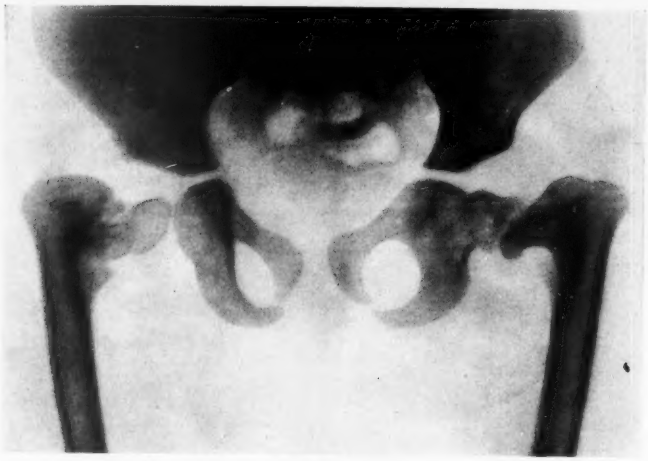

FIG. 7

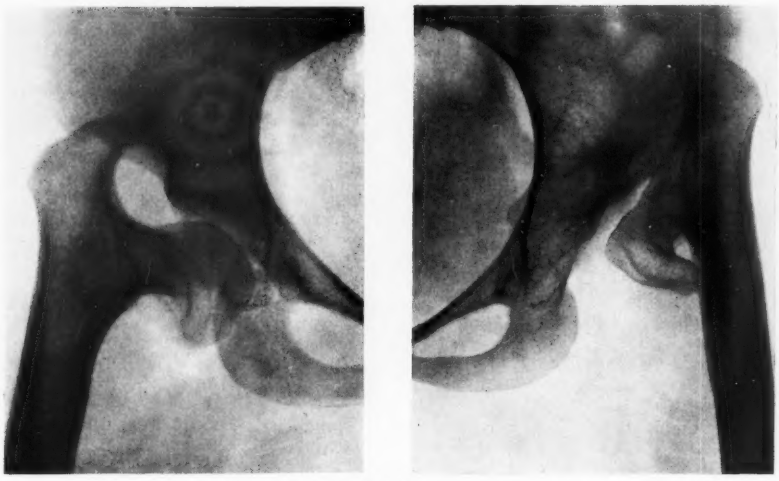

FIG. 8

Bilateral developmental coxa vara at the age of three years (Fig. 7) and at the age of sixteen years (Fig. 8) in a patient who received no treatment. The gap in bone closed completely but with marked deformity. Nevertheless the gait was extraordinarily good.

end, it divided into two, leaving a triangular portion of bone more or less isolated. The gap was not broad and it did not follow a straight line with clear-cut edges; the margins were usually uneven. The bone was abnormal in appearance, particularly just distal to the gap; irregular areas of greater density alternated with areas of lesser density, thus giving rise to the appearance which is often described as "fragmentation." In no case was there increased density of the femoral head suggesting necrosis of the bone such as may occur in slipped epiphysis, or in fractures at this level. As a matter of fact the density of the head was often less than normal. The epiphyseal line was usually narrow, and sometimes it could be seen

FIG. 9

FIG. 10

Developmental coxa vara in a patient, aged six years, before operation (Fig. 9). Same patient two years after subtrochanteric osteotomy (Fig. 10). The gap in the bone has closed completely. There was no limp.

only with difficulty. It should be noted that in this condition the characteristic gap in the bone is not the epiphyseal line: developmental coxa vara must not be confused with slipped upper femoral epiphysis which is more common, and in which deformity occurs at a different level and at a later age.

In some early cases of coxa vara in which the deformity was not marked, the gap in the bone ran in a direction more horizontal than vertical (Fig. 2). As deformity increased the head rotated downwards, and both the gap, and what could be seen of the epiphyseal line, became more vertical. In most cases seen at about the age of eight years varus deformity

FIG. 11

FIG. 12

FIG. 13

Coxa vara in patient aged five years (Fig. 11). Fig. 12 shows radiograph two months after osteotomy. Two years later the gap has not closed and the deformity has increased (Fig. 13); probably due to insufficient abduction at the osteotomy.

was rather marked, and the neck was short, particularly at its lower margin, thus giving the impression that there had been collapse of the tissues forming it (Fig. 3). In cases seen at about the age of twelve years the appearance of bone fragmentation was less marked and the gap was narrower. In the three cases which were seen at the age of more than sixteen years the gap had bridged completely and the neck was in one piece with bone of almost normal texture (Figs. 4 to 8). In these untreated cases, the final degree of deformity varied greatly; as a rule it went on to the extreme limit, but occasionally it never progressed beyond the right angle.

PATHOLOGY OF DEVELOPMENTAL COXA VARA

We did not remove tissue for histological examination and we cannot add information as to the origin and cause of this condition. The explanation which is generally accepted is that it is due to faulty development of the neck of the femur, with imperfect formation in cartilage, and with delayed and incomplete ossification of the cartilage. While this explanation does not entirely fit the picture it is probably the correct one. Varus deformity is no doubt caused by gradual bending of the unossified cartilage. Shortening of the femoral neck is due partly to this bending but largely to lack of growth at the epiphyseal line which is never normal in appearance and always undergoes premature fusion.

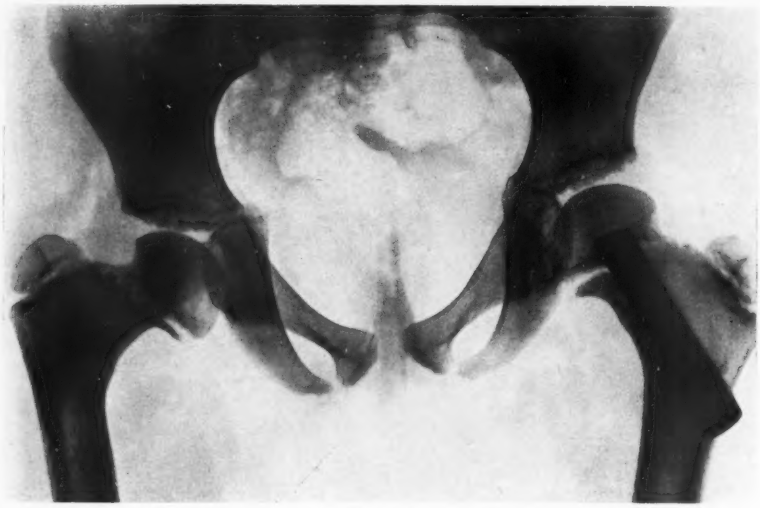

FIG. 14

Bilateral coxa vara in a patient aged six years (for original condition see Fig. 2) treated by nailing on one side and bone grafting on the other. Radiographs eleven months after operation show considerable closure of the gap on the grafted side, but little closure on the nailed side.

Clinical course—The usual course of the condition is well known. The gap in the bone is present at an early age. Without treatment the deformity increases slowly at a varying rate and to a varying extent over a period of years. At about the age of twelve years increase in the deformity ceases. Finally, in most cases at any rate, the gap in the bone heals, leaving a deformity which is usually severe but which sometimes is only moderate.

TREATMENT OF DEVELOPMENTAL COXA VARA

Two factors must be considered in treatment, namely: the coxa vara deformity; and the gap in the femoral neck. The deformity causes shortening of the limb and limitation of abduction movement of the hip. If it is severe it gives rise to a marked limp and should be corrected, or in some way compensated.

Treatment by traction—We have tried to correct the deformity by strong traction and forced abduction at the level where it takes place, that is to say at the gap in the bone. All that we have succeeded in doing is to pull the femoral head almost out of the acetabulum without changing the angle of the neck in the slightest. We have concluded that, although

FIG. 15

FIG. 16

Developmental coxa vara in patient aged six years (Fig. 15). Three months after bone grafting the gap is almost completely closed (Fig. 16).

FIG. 17

FIG. 18

Coxa vara in a patient aged three years (Fig. 17). Four months after insertion of a bone graft the gap in the bone is closing satisfactorily (Fig. 18).

deformity may increase gradually, the neck is nearly always too rigid at the gap to be bent straight by closed manipulations. It seems unwise to complete division of the neck at the gap by operation, or to do an osteotomy through the neck distal to the gap; and we have not tried either.

Treatment of late cases by trochanteric osteotomy—Unless the deformity is very severe indeed, limitation of abduction can be overcome and shortening can be reduced by the safer procedure of osteotomy between the trochanters, or below them, the lower fragment being abducted widely. We have performed this operation on twelve hips. The osteotomy always united rapidly and the limp either disappeared or was much improved. Besides overcoming deformity, the abduction osteotomy did something else. In every case that we have been able to follow long enough, with one single exception, the gap in the bone healed completely within a year, and in a much shorter time than would have been possible without operation (Figs. 9 and 10). This healing of the bone defect was probably attributable to change in the line of weight-bearing at the gap from a shearing stress to a compressive force. In the one case that did not heal, it is probable that the fragments were not abducted widely enough at the osteotomy (Figs. 11–13). At the end of two years the gap was still open and the deformity of the neck had increased. Recently another osteotomy has been performed on this patient with more abduction of the fragments.

Importance of wide abduction at the site of osteotomy—The importance of gaining sufficient abduction at the site of osteotomy must be emphasized. This is necessary not only to secure closure of the gap in the femoral neck, but also to overcome the disability caused by deformity. The best results were obtained when the distal fragment was abducted sixty or seventy degrees at the level of osteotomy. In doing the operation, attention must be paid to the relative length of the two limbs. The affected limb is shortened by deformity of the neck. It is, therefore, wise to do the osteotomy between the trochanters, and to prevent shortening due to over-riding of the fragments, either by using some form of internal fixation or by applying traction to the limb after operation. Flexion deformity at the hip joint can be overcome at the time of the osteotomy.

Treatment of early cases by nailing and grafting—Abduction osteotomy is a satisfactory method of treatment for cases in which the coxa vara deformity is bad enough to require correction. It leaves a hip joint which may not be perfect in function, but which is much better than it was, and which is unlikely to get any worse for the reason that the gap in the neck is closed. It must be recognised, however, that some hips are seen before the coxa vara deformity has become at all marked, and before it is bad enough by itself to produce any limp. The diagnosis is made obvious by the radiographic appearance and it is almost certain that, without treatment, deformity will increase steadily until the gap in the bone closes. In these early cases the most important thing is to close the gap before deformity becomes disabling, and it would seem better, if possible, to do this without osteotomy which may distort the mechanics of the hip. Since healing of the gap after osteotomy seemed to be due to elimination of the shearing forces, it was thought that the same result might be obtained by the insertion of a Smith-Petersen nail. This was done in one hip of the patient shown in Fig. 14. After eleven months, the gap was still widely open. In the other hip of the same patient, a few days after nailing the first hip, a large drill was passed up the neck of the femur into the head; into this drill-hole two tibial bone grafts, placed cortex to cortex, were inserted tightly. Eleven months after operation, the gap in the bone was pretty well healed; repair was much more advanced than on the side which had been treated with a Smith-Petersen nail.

Since then two other cases have been treated by grafting; in both the gap is healing well, one after three months, and the other after four months (Figs. 16, 18). It would seem that this is much the best way to secure closure of the gap. The most striking thing about these

three grafted cases, one with a nail in the other hip, is that all are walking and running normally and all have lost the limp they had before operation, although there has been no change in the degree of coxa vara deformity. It would appear that weakness or instability at the site of the gap in the bone is an important element of the limp, and that if the gap can be closed before the coxa vara becomes sufficiently severe to cause disability, the symptom should disappear. The objection that at this age a bone graft across the epiphyseal line may arrest growth applies very little in these cases, because in any event growth in length here will be almost negligible.

SUMMARY

Most of what I have said has been said before by various writers. Abduction osteotomy is the recognised form of treatment for developmental coxa vara. The results from this operation are usually good. But the results of treatment would probably be better if the condition could be diagnosed before deformity had become disabling, and if the gap in the bone could be closed by other means than osteotomy. Good results of bone grafting in early cases of developmental coxa vara are reported.

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CONGENITAL ELEPHANTIASIS ASSOCIATED WITH CONSTRICTION BY ANOMALOUS BANDS

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Congenital constricting bands of the extremities are not uncommon. These bands may take the form of complete, or of incomplete, circles of varying depth. They vary from sloping concavities of the skin and subcutaneous fat, to sharp indentations with firm circular compression. The fingers and toes are most often affected. Multiple constrictions may be present, encircling either the digits or the limbs. Associated deformities are often found. There may be absence of part of a toe, finger, leg, or arm; or varying degrees of fusion of the digits to one another; or absence of the interphalangeal joints, with one or two long phalanges instead of three; or rudimentary phalanges with distorted interphalangeal joints; or points of deep dimpling of the skin. Unrelated congenital abnormalities may also be present, such as cleft lip and cleft palate. That all these anomalies may be present in one individual is demonstrated in Figs. 2 and 3, which show a child with hare lip (photograph taken after repair), cleft palate, incomplete and complete absence of digits, fusion of phalanges, webbing of fingers, equinovarus deformity of one foot, incomplete and complete constricting bands of one leg, and points of dimpling.

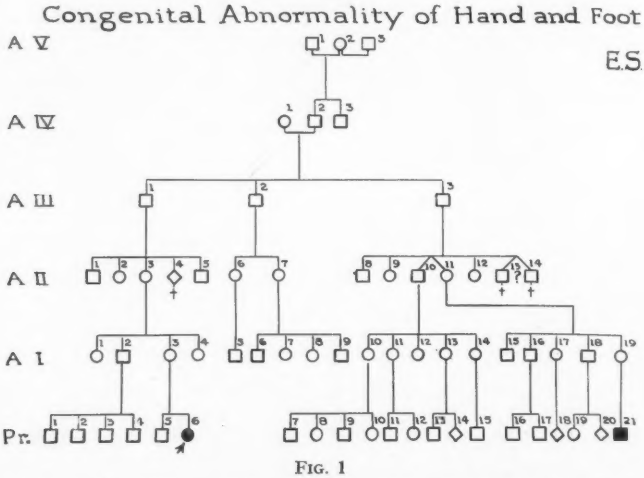

FIG. 1

Pedigree of two children with marked congenital anomalies of the feet and hands, one with a loose circular constriction of the forearm (see Fig. 4).

Familial and pre-natal influences—Discussion of the pre-natal influences which bring about these deformities will not be undertaken; the author has nothing new to add. Fig. 1 shows the pedigree of two children with marked congenital anomalies. One exhibited abnormalities of both feet and one hand with a loose circular constriction of the forearm (Fig. 4). The other was a distant cousin who was not examined, but of whom a photograph showed absence of digits and part of the thumb of one hand. The tracing of such deformities among ancestors is a most difficult if not impossible task, demanding intense effort on the part of interested investigators; little significance must be attached to failure to secure evidence of such familial tendencies. While in one individual patient, ring-like depression

FIG. 2

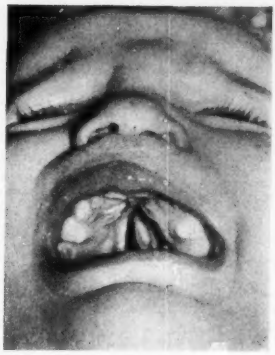

FIG. 3

Multiple congenital anomalies in one child, including hare lip, cleft palate, absence of digits, fusion of phalanges, webbing of fingers, equinovarus deformity of the foot, complete and incomplete constricting bands of one leg, and congenital dimpling.

FIG. 4

Congenital anomalies of the right hand with loose circular constriction of the forearm (see pedigree—Fig. 1).

FIG. 5

Constricting band of the digits with marked subcutaneous thickening of the index finger.

of an extremity may be the only anomaly found, it is probably the least significant manifestation of an inherited tendency contributing to the production of a variety of more obvious and disabling deformities.

FIG. 6

Male child, aged four months, with multiple congenital anomalies of the hands and feet, and with enormous swelling and lymphoedema of the left foot distal to a tight constricting band encircling the limb above the malleoli. Operative treatment was carried out as indicated in Fig. 7.

Subcutaneous thickening and lymphoedema—Distal to a constricting band there may be considerable increase in the thickness of subcutaneous tissues. This has often been noted in the fingers (Fig. 5). The blood flow into such enlargement of the digits is good, and there is seldom increase in the lymph. On the other hand when there is a tight constricting band

higher in the limb, astonishing degrees of lymphoedema may sometimes occur (Bize and Grisel 1904). The chief purpose of this publication is to report the treatment of such a case.

Case report—A male child, four months of age, was admitted to hospital with multiple congenital anomalies of the hands and feet. There was no history of deformity in the child's ancestors. The right hand showed fusion of the tips of the middle, index, and ring fingers. In each finger there was one large and one small phalanx. The thumb had one phalanx. The left hand showed absence of the tips of the fingers, with one normal phalanx for each finger. The thumb was normal. The big toe and parts of the other toes were absent from the right foot. The left foot presented a tight constricting band which wholly encompassed the limb above the malleoli (Fig. 6). Below this encirclement was a tremendous enlargement. The skin was shiny and tight, and it had a transparent, waxy appearance. The tissues were firm. There was no pitting on pressure. After digital compression there was immediate return to the original shape. Radiographs showed very great soft tissue thickening, but there was no abnormality of the bones.

Operative treatment—The condition was treated by three operative procedures carried out at intervals of approximately two weeks. The first two operations were similar in nature: first, the anterior half, and then the posterior half, of the constricting band was excised. In each case a strip of tissue, one quarter of an inch wide and half the circumference of the limb, was excised in the line of the band (Fig. 7). Transposition of flaps was accomplished by means of a "Z" plastic manoeuvre from the normal area above, into the abnormal area below, and vice versa. This was performed on so large a scale as to remove the indentation from the whole circumference of the limb. At a third-stage operation, skin and subcutaneous tissues were removed from the dorsum of the foot down to the deep fascia. Part of the skin was converted into a free, full-thickness graft by excision of all subcutaneous fibrous tissue. It was then replaced and a pressure dressing was applied. In one area there was some loss of skin which was replaced later by a split-skin graft.

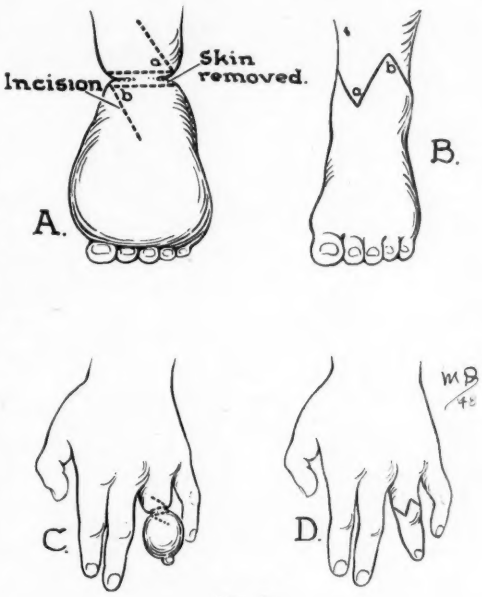

FIG. 7

"Z" plastic operation for removal of a strip of tissue at the site of encircling bands.

Laboratory examination of tissue fluid—At the original operation, when the incision was first made, clear fluid flowed from the wound as blood might flow from a large vein. Four test tubes were filled with this liquid which on analysis showed a serum protein content of 2·2 grams per cent. Laboratory reports showed that only albumin was present. The fluid did not clot even after several hours. Microscopic examination showed no more than a few lymphocytes.

Histological examination of removed tissue—The great increase in thickness of the epidermis of the skin from the dorsum of the foot is shown in Fig. 12. In a section of the deeper tissues large lymph channels can be seen clearly (Fig. 13).

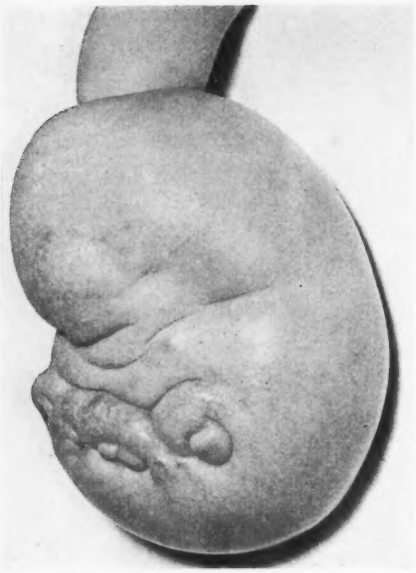

FIG. 8

Photograph of the foot, in the case reported before operative treatment.

FIG. 9

Within a few days of the first operation there was remarkable shrinkage of tissue.

FIG. 10

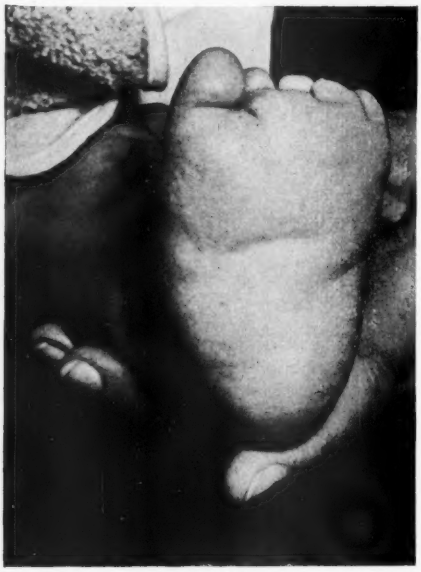

FIG. 11

After the completion of operative treatment, including two "Z" plastic resections of the constricting band, resection of skin and subcutaneous tissue from the dorsum of the foot, and whole thickness and split-skin grafting, the foot is almost normal in appearance and function.

Post-operative course—The condition of the foot before operation is shown in Fig. 8. It was almost impossible to recognise the shape of the toes. Within a few days of the first operation there was remarkable shrinking of tissues (Fig. 9). By the time the patient was discharged from hospital, after the third operative procedure, the foot was almost normal in appearance (Fig. 10). Re-examination several months later showed that the cosmetic appearance was still satisfactory and function was excellent (Fig. 11). There had been no recurrence of swelling or enlargement of the limb.

DISCUSSION

Enlargement of an extremity at birth may be due to a number of factors other than constricting bands. Cooperstock (1939) indicated that the three chief causes of congenital enlargement were: 1) lymphangiectasis; 2) haemangiectasis and congenital arteriovenous

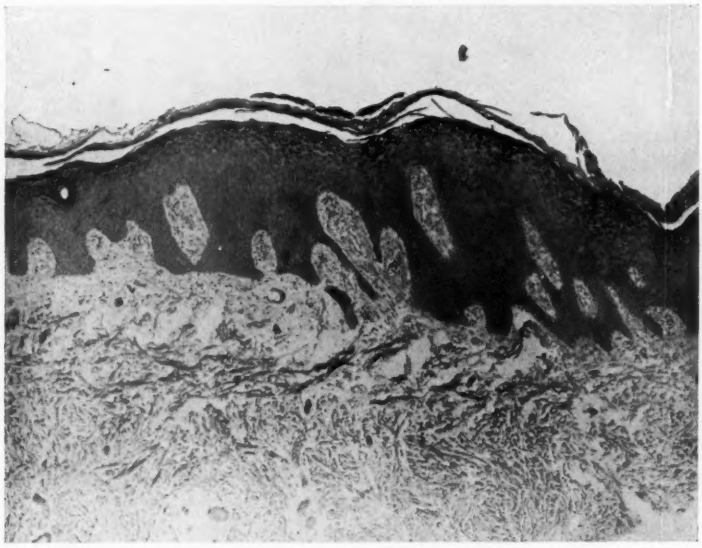

FIG. 12

Section of skin from the dorsum of the foot in the case shown in Fig. 6. There is great increase in the thickness of the epidermis.

anastomoses; 3) Recklinghausen's neurofibromatosis. In all forms of elephantiasis there is overgrowth of connective tissue. It has been suggested by Homans (1940) that the proteinised fluid acts as a tissue culture medium and encourages fibrosis. In the case here reported, the elephantiasis was undoubtedly due to blockage of veins and lymphatics in the region by a tight encircling indentation. It is unbelievable that this could be the result of pressure from an amniotic band about the limb. Such is discussed by Ballantyne (1902) who noted that "pictures of them are to be found in the older works on monstrosities."

The use of the "Z" plastic manoeuvre for the correction of such constrictions is not new. Ferris Smith (1946) warned against the use of incisions around the entire circumference of the constriction in cases without lymphoedema. It was indicated that in one such case swelling still persisted many years after operation.

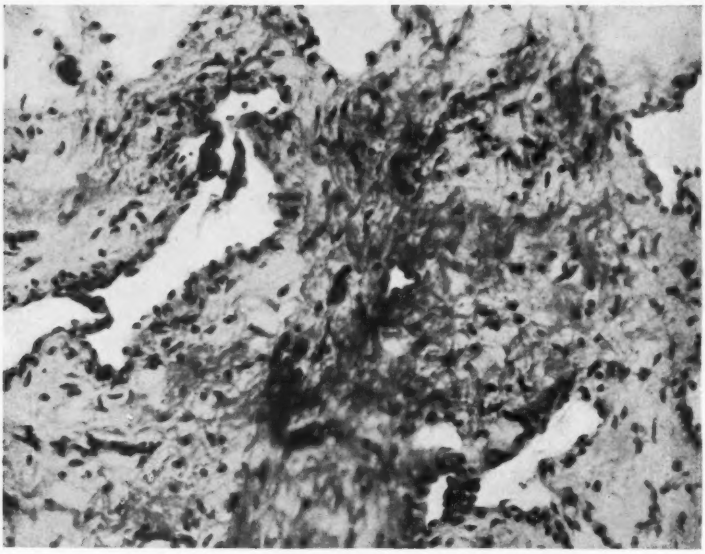

FIG. 13

Section of subcutaneous and deeper tissues from the foot in the case shown in Fig. 6. Large lymph channel can be seen clearly.

SUMMARY

Congenital anomalous bands of the extremities are variable in position, depth, and in the completeness of their encirclement. They represent one of a group of abnormalities which are often present in the same individual. Cases associated with gross lymphoedema are rare. The treatment of such a case is presented.

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SPINAL EXTRADURAL CYSTS

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Spinal extradural cysts are rare. In 1944, Good, Adson, and Abbott presented the twenty-first recorded case. In 1945, in a review of epidural lesions producing cord compression, two other cases were reported by Shenkin, Horn, and Grant. Hyndman and Gerber added a further case in 1946. So far as we know the case now reported is the twenty-fifth to be recorded in the literature.

Two types of spinal extradural cyst—There appear to be two distinct clinical pictures associated with spinal extradural cysts. Elsberg, Dyke, and Brewer (1934) defined the first: the patient is an adolescent with the history and symptoms of progressive spastic paraplegia; radiographic examination shows dorsal kyphosis of the Scheuermann type with signs of an expanding tumour in the neural canal in the dorsal region. This clinical type has been confirmed by Cloward and Bucy (1937), Adelstein (1941), Turnbull (1939), and Lehman (1935).

The second type occurs in adults, usually in the lumbo-dorsal spine. The cyst is not associated with dorsal kyphosis. Cloward's patient was a man aged forty-three years with a two years' history of symptoms. There was no dorsal kyphosis and radiographic examination indicated an expanding intraspinal lesion in the upper lumbar region, very similar to the case reported here. A second case of spinal extradural cyst in an adult was described by Good, Adson, and Abbott (1944). The patient was a male, aged forty-two years, with old dorsal juvenile kyphosis, who had been perfectly well for at least twenty-four years before the onset of symptoms. The cyst was lumbo-dorsal in position and did not appear to be related in any way to the kyphosis.

Case report—Mrs E. J. C., a European woman aged forty-two years, was in good health until one month after the birth of her first child fifteen years previously. She then developed weakness of the left leg which made her fall, even when walking over level ground. Shortly afterwards she complained of pain in the lumbar region, and cramps in the left foot especially when lying in bed. On walking, the left foot went into eversion.

Weakness and cramp in the left leg increased during the next four years, when mild symptoms developed in the right foot and calf. She again became pregnant. The backache became worse and, soon after the birth of her second child, five years after the first onset of symptoms, the pain began to radiate down the back of the left thigh.

Shortly after the onset of symptoms she had developed stress incontinence which a gynaecologist attributed to birth trauma. The incontinence increased gradually and, after the birth of the second child, perineorrhaphy and ventro-suspension were performed but without improvement.

All symptoms steadily became worse and eleven years after the onset her legs were so weak that she needed support when walking. Severe muscle cramps involved the whole left lower limb. Rising from a chair was very difficult owing to backache. There was spasticity of the left calf muscles with equinus deformity which increased her difficulty in walking.

When first seen by us, after fifteen years, she had atrophy and spasm of the left thigh and calf muscles. Voluntary power in the whole of the left lower limb was weak. The knee jerks were brisk, more so on the right than on the left. The ankle jerks were brisk and equal on both sides. There was impaired cutaneous sensation below the level of the tenth dorsal nerve root. Sense of joint position, passive movement, and vibration was absent on the left and normal on the right. There was Rombergism.

Radiographic appearances—X-ray films of the middle and upper dorsal vertebrae showed normal appearances. There was no wedging, kyphosis, or irregularity of disc spaces, such as are seen in old adolescent kyphosis. The lower dorsal and upper lumbar vertebrae showed definite changes. In the lateral film the vertical interpeduncular distances were increased; and the antero-posterior view showed flattening and atrophy of the medial aspects of the pedicles. The interpeduncular distances showed irregular variation in place of the

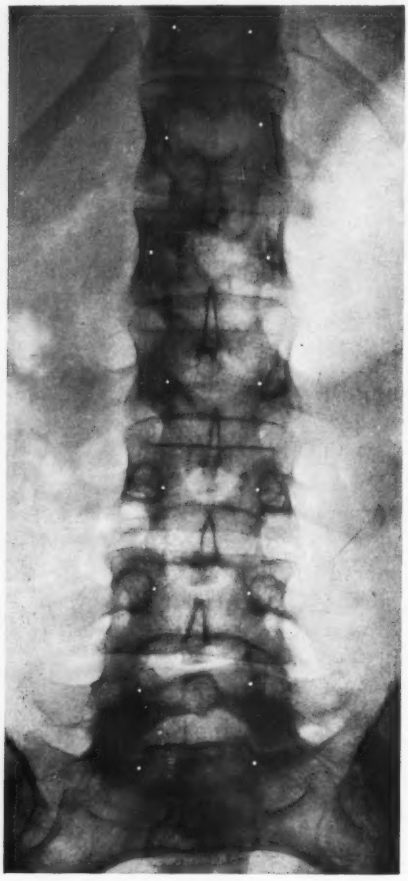

FIG. 1

FIG. 2

Radiographs show pedunculated erosion with increased width of the neural canal (Fig. 1). The lateral view shows excavation and hollowing of the posterior surface of vertebral bodies, and much enlarged intervertebral foramina (Fig. 2). Note that there are six lumbar vertebrae.

normal regular increase in the caudal direction (Fig. 1). The tenth and eleventh dorsal, and first and second lumbar vertebrae, showed abnormal measurements:

Vertebrae.	D_9	D_{10}	D_{11}	D_{12}	L_1	L_2	L_3	L_4	L_5	L_6
Interpeduncular distances (in mm.)	21	23	24	22	**29**	**36**	28	29	30	34

In the lateral projection there was marked hollowing of the posterior surfaces of the bodies, particularly from the tenth dorsal to the third lumbar vertebrae. Narrowing of the pedicles

in the vertical diameter, with consequent enlargement of the intervertebral foramina, was also evident in this view (Fig. 2). These findings were interpreted as indicating the presence of a large mass within the spinal canal, extending from the tenth dorsal to the third lumbar vertebrae, and causing pressure changes in adjacent bone.

Myelographic examination—Myelography was done by injecting 4 c.c. of lipiodol into the cisterna magna; this passed normally as far as the first lumbar vertebra where it broke up into globules (Fig. 3). The globules passed beyond the normal confines of the spinal theca and through the intervertebral foramina to lie three to four centimetres from the midline (Fig. 4). They could not be returned into the neural canal by alteration of position. In the erect position, the lipiodol partly outlined a circular mass at the level of the first lumbar

FIG. 3

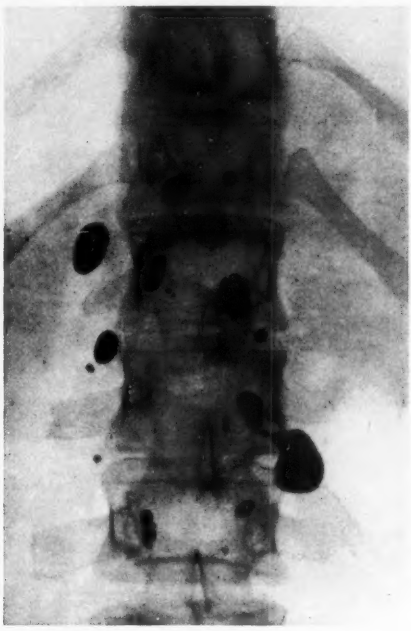

FIG. 4

Myelography shows the enlargement of the neural canal (Fig. 3). The lipiodol passed beyond the normal confines of the spinal theca and through the intervertebral foramina (Fig. 4).

vertebra. This lipiodol corresponded in position to the theca, which appeared to be indented by the mass. The globules passed beyond the main obstruction at the first lumbar level but they were held up at the second lumbar vertebra. On re-examination forty-eight hours later, the globules were again observed outside the neural canal and the other features described remained constant. These myelographic findings indicated the presence of a large mass in the spinal canal, deforming the theca at the level of the first lumbar vertebra and obstructing it at the level of the second and third lumbar vertebrae. The passage of globules of lipiodol beyond the lateral limits of the neural canal suggested recesses, or diverticula, communicating by means of a narrow neck with the subarachnoid space.

Operation—Laminectomy from the tenth dorsal to the third lumbar vertebrae was performed. When the spinous processes were divided it was found that the bases of two had been eroded

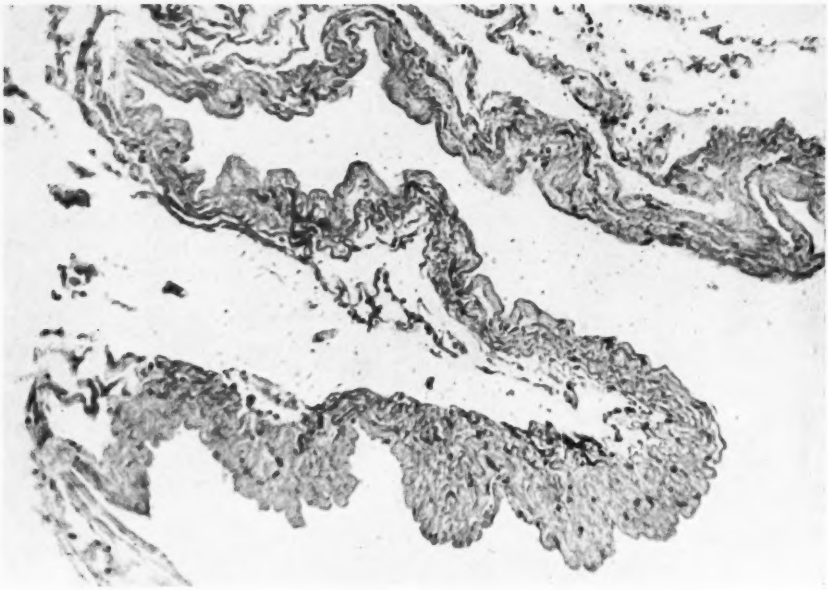

FIG. 5

Section of the wall of the spinal extradural cyst (low power magnification).

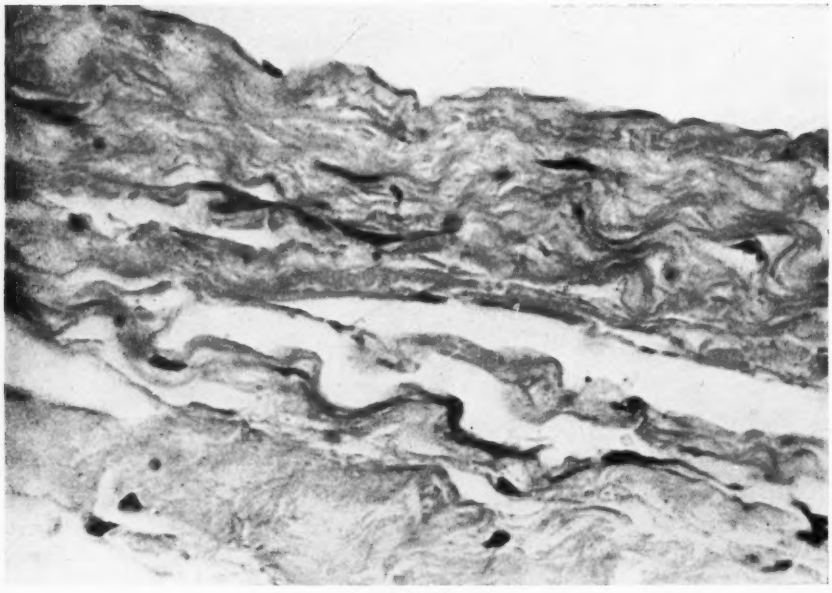

FIG. 6

High power magnification of a section of the cyst wall showing its simple structure, resembling arachnoid-mater, but without endothelial lining.

from inside the spinal canal; they showed smooth depressions. The laminae were very thin and could be cut with a scalpel. When they had been removed, a thin-walled cyst, blue in colour, was seen lying posterior to the dura, but extending laterally on both sides and actually protruding through the intervertebral foramina.

Closer examination showed that there were three large cysts each containing clear colourless fluid. They were very thin walled and, except at the exit of two nerve roots where the cysts were closely adherent, could easily be dissected off the dura. In this dissection the dural sac was opened and clear cerebro-spinal fluid escaped. The spinal canal was found to be very much widened. The cord and cauda equina were compressed and smaller than normal.

Histological examination of the cyst—Macroscopically, the specimen consisted of a collapsed cyst with a thin wall. Microscopic section showed connective tissue without any characteristic lining (Figs. 5 and 6).

Post-operative course—After operation the spasticity of the right lower limb disappeared rapidly and that of the left lower limb more slowly. The sense of position, of passive movement, and of vibration in the left lower limb recovered gradually. After six weeks the patient walked with crutches. When last seen she was walking well, without assistance, and although there was some valgus deformity of the left foot she considered that her recovery was complete.

DISCUSSION

The origin of spinal extradural cysts has not been established finally. Elsberg, Dyke, and Brewer consider that " the extradural spinal cyst is due to a congenital diverticulum of dura mater, or to a herniation of arachnoid through a congenital defect in the dura." The latter hypothesis is supported by the case now reported because although the wall of the three cysts lacked endothelial lining it resembled arachnoid-mater in structure. The cysts were attached by pedicles to the dura round two nerve roots in the region of the intervertebral foramina; and though it was not possible to state whether these narrow pedicles were patent it was considered, on the basis of radiographic evidence, that at least one was open and communicated with the subarachnoid space.

Excluding the present case, four extradural cysts have been described in adults by Good, Adson, and Abbott (1944), Shenkin, Horn, and Grant (1945), and Adelstein (1941). Three were situated in the lumbar or dorso-lumbar regions and no dorsal kyphosis was present. In the fourth case there was old adolescent kyphosis but it appeared to have no relationship with the late development of a dorso-lumbar cyst (Good *et al.* 1944).

It would seem that there is a tendency for lumbar extradural cysts to become manifest at a later age than dorsal cysts. A likely explanation is that the lumbar canal is spacious; and the cauda equina is readily displaced, so that cysts may grow without giving rise to symptoms for a longer period in the lumbar spine than is possible in the dorsal region.

Cloward and Bucy suggested that " kyphosis dorsalis juvenilis may be the result of venous congestion and stasis in these vertebral bodies, whatever the cause of the vascular disturbance." They postulate that the kyphosis which is associated with an extradural cyst might be the result of obstruction of venous return by the cyst. This suggestion is not supported by the fact that there was no vertebral deformity in the four reported cases of lumbar cysts. Venous drainage of the dorsal and lumbar vertebrae is similar, and obstruction might reasonably be expected in the lumbar region with cysts large enough to produce excavation of the posterior surfaces of the bodies of the vertebrae. It is by no means generally accepted that venous congestion plays any part in the development of kyphosis of the Scheuermann type.

SUMMARY

1. Two types of spinal extradural cyst are discussed: 1) the type which occurs in adolescents in the dorsal spine with evidence of kyphosis juvenilis; 2) the type which occurs in adults in the dorso-lumbar spine without kyphosis.

2. A fifth case of dorso-lumbar spinal extradural cyst in the adult without deformity is reported. Cysts in this region present common features distinguishing them from the more frequent type which occurs in adolescents.

3. The relationship between spinal extradural cysts, venous drainage of vertebral bodies, and spinal deformity, is discussed.

We are grateful to Professor J. Barnetson of the Department of Pathological Anatomy for the photomicrograph of the cyst wall and for his opinion on the sections.

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ARTHRODESIS OF THE ANKLE JOINT

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Some years ago I had the honour of presenting to the American Orthopaedic Association a method of arthrodesis of the subastragaloid joint for which was claimed the merit of simplicity and comparative infallibility. At the same time it was mentioned that the same principle had been used in the ankle and other joints but that sufficient time had not elapsed to justify a formal report. The results of these operations can now be considered final, and it is time that they were recorded.

It is not necessary to discuss the indications for arthrodesis of the ankle, or to dilate on the excellence of the functional results which can be expected after successful operations, for all this is well known. It has been my experience, however, that with methods commonly in use there is often failure to obtain solid, painless, bony union, and there is often regrettable increase in the deformity. An operation which involves opening the joint widely, removal of all articular cartilage, accurate fitting of the raw surfaces, and the introduction of a bone graft, is one which calls for craftsmanship and which cannot be done without some risk of infection. Furthermore, free removal of the weight-bearing articular surfaces lowers the level of the joint and may give it a thick and ugly appearance which in the case of women is objectionable. Besides this, after thorough removal of articular cartilage the astragalus no longer fits its mortice but resembles somewhat a dry pea in its pod. As a result it is difficult to hold the foot in the correct position and to maintain accurate contact of the raw surfaces in the joint during closure of the wound and the application of plaster.

To overcome these objections an operation was devised. Through two short vertical incisions, one in front of each malleolus, the ankle joint is opened and the articular surfaces are exposed. A wide thin osteotome is then applied to the lower end of the tibia and astragalus by which to cut a deep mortice about an inch and a half long and a quarter inch wide, which in its upper half is in the lower end of the tibia and in its lower involves the articular surfaces of the malleoli and astragalus. These mortices should be cleanly cut with exactly parallel walls, at least one inch deep. Through a third incision in the middle of the leg a bone graft is cut from the medial surface of the tibia, three inches long and one inch wide. This is divided transversely into two equal parts. Each is hammered solidly into one of the mortices. If they have been cut accurately the grafts should fit so tightly that the joint is then and there ankylosed in the proper degree of equinus; there is no danger of displacement during suturing of the wounds or application of the plaster.

Points to be noted in this operation are that it involves minimal exposure; that it leaves the weight-bearing articular surfaces intact and does not cause shortening; and that, unless there are complicating lateral deformities to be corrected, it can be completed in less than thirty minutes. It depends for success on the accurate fitting of two wide cortical bone grafts so placed that, when weight-bearing and walking are begun, the stresses and strains come on the grafts edgewise and so without risk of breaking them.

The results have been satisfactory. The operation has been performed twenty-five times over a period of eight years and has never failed to produce painless arthrodesis. It has been our routine to leave the original plaster in position for three months, and then to apply a walking plaster which is worn for another month. Patients usually return to work at the end of six or seven months.

When there is varus or valgus deformity the technique may require modification. Osteotomy of the fibula may be required, or it may be necessary to remove enough of the edge of a tilted astragalus to let it go back into correct relationship with the leg. Indeed,

* *Paper read at the combined meeting of the American, British, and Canadian Orthopaedic Associations in Quebec, June* 1948.

FIG. 1

FIG. 2

Traumatic arthritis of the ankle joint with gross articular changes causing much pain (Fig. 1). Radiograph three months after operation (Fig. 2).

FIG. 3

Radiograph of the same ankle joint as shown in Figs. 1 and 2, taken four years after operation showing sound fusion.

slight variations of the technique are often necessary to suit the particular case. Nevertheless the same principle is always observed, of keeping the operative interference to a minimum and depending solely on the grafts for fusion.

The changes occurring in these joints after operation have been recorded in X-rays. At first the grafts stand out sharply in contrast with the walls of the mortices. Gradually, however, the edges become blurred and the hard cortical bone becomes softened until finally, in a year or two, it is replaced completely by new bone and has become part and parcel of the bed in which it was placed. It looks as if, with the lapse of time, the articular cartilage on the weight-bearing surfaces becomes ossified so that ultimately the bones are fused throughout.

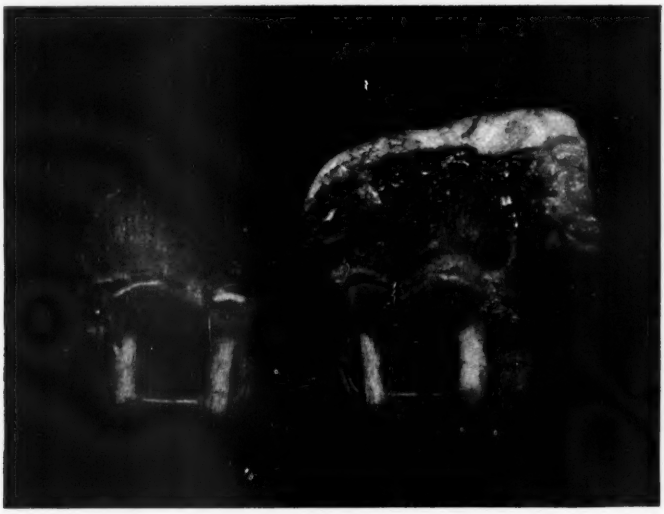

FIG. 4

Colour photograph of specimen recovered by Symes' amputation thirteen months after arthrodesis of the ankle by bone blocks, showing solid fusion of the joint by means of the graft.

We were fortunate enough to obtain a specimen thirteen months after operation which demonstrates beautifully all the gross and histological changes which occur. The specimen has been sawn in the coronal plane in order to show the relationship of the grafts to the tibia and astragalus and the solidity of fusion (Fig. 4). Microscopic examination shows revascularisation and gradual replacement of the cortical graft by new bone from the surfaces.

After the remarks of our President on the desirability of more fundamental research I have felt almost ashamed to present a paper which deals solely with a problem of technique. Nevertheless, those of us who attended these meetings thirty-five years ago will recall that about that time Phemister and I were talking a lot about what happened to the bones of animals on which we were operating, and that we have been thinking and talking about these problems ever since. It is only now, after retiring from active University work, that we have time to think of some of the practical applications of the researches we did. Possibly my excuse should be that as we grow older we seek easier ways of doing our operations, and more certain methods of protecting our reputations by lessening the risk of failure.

FATIGUE FRACTURE OF THE ULNA

IAN D. KITCHIN, LANCASTER, ENGLAND

Fatigue fractures have been demonstrated in the metatarsals, fibula, tibia, shaft of the femur, neck of the femur, pubis, vertebrae, and first rib. With the exception of the first rib, these sites have in common the fact that the bones bear part of, or all, the body-weight in addition to any load which may be carried. Even in the case of the first rib it is known that a weight-bearing strain may be applied by carrying weights on the back and shoulders. Hitherto, no case has been reported of fatigue fracture of a long bone where body-weight was not an etiological factor, and although I do not think that this report of a fatigue fracture of the ulna will in any way alter or elucidate the theories already put forward as to etiology, it may nevertheless be of interest.

The patient was a well-built, right-handed, intelligent farm worker, aged twenty years. When first seen in February 1946, he complained of pain in the left forearm of three weeks' duration. There was no history of injury. The pain started while he was carting farmyard manure. He used a stable fork in filling his cart from a tightly packed heap. The pain did not prevent him from carrying on with his job. It seemed to trouble him most at night. He had difficulty in getting to sleep, but once asleep the pain did not waken him.

On examination there was fusiform swelling of the middle third of the forearm with heat, tenderness, and slight oedema. There was no creaking. There was full range of wrist and elbow movement. Radiographic examination showed a fracture of the mid-shaft of the ulna (Fig. 1) which was described by Dr R. Fawcitt thus: " Considerable callus formation is seen in the region of the fracture. There is periosteal reaction extending upwards and downwards along the greater part of the diaphysis of the bone. The fracture has the appearances associated with a stress fracture, or possibly a fracture due to direct violence. There is no X-ray evidence of expansion of the shaft of the bone such as occurs in bone tumours."

A plaster cast was applied from the mid-palm to the axilla, and was kept in position for ten weeks. There was then freedom from pain and no heat. A large mass of callus could be felt. Radiographic examination showed increased callus formation. Union was taking place satisfactorily, but it was not complete, and indeed the line of fracture was more apparent than in the first radiograph (Fig. 2). It was considered safe at that time to leave the arm without support. No physiotherapy was used. By June 1946, four months after the first onset of symptoms, he started light work and gradually resumed normal duties. At first there was some recurrence of pain, but eventually he made a complete recovery. Radiographs in April 1947 showed faint evidence of the original fracture line, but union was soundly consolidated and the contour of the bone was restored almost to normal (Fig. 3).

In deciding whether or not this was a fatigue fracture, due weight must be given to the history. Even after the most searching inquiry there was no history of a fall, blow, or other injury. Workmen's compensation was not claimed. It must be admitted that the work was heavy. During the loosening of forkfuls, and while raising them, the left hand was the fulcrum and the left forearm supported both the downward thrust of the right hand and the pull of the resisting load. The resulting strain on the left forearm was very considerable. Nevertheless no specific injury was recognised.

The similarity of radiographic appearances in this case with those of fatigue fracture of the metatarsal bones should be noted; they are unlike those of fatigue fractures of the long bones of the lower limb. The explanation may be that in the case of fracture of the metatarsal, and of the ulna, the forces act at an angle of approximately 90 degrees to the

FIG. 1

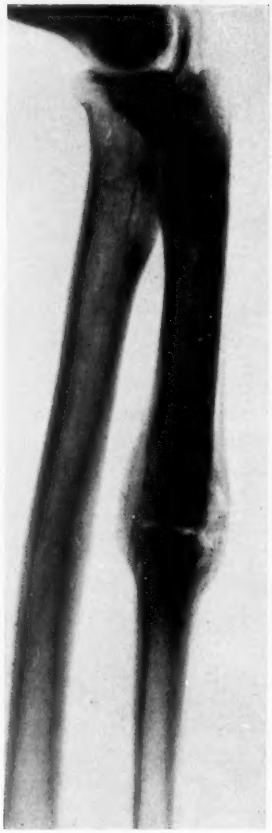

FIG. 2

FIG. 3

Fatigue fracture of the ulna which developed without any history of injury after forking and carting farmyard manure. When first seen, three weeks after the first onset of symptoms, there was a fracture of the mid-shaft of the bone with callus formation (Fig. 1). Ten weeks later, after immobilisation in plaster, the fracture was united (Fig. 2). Final consolidation was evident after fourteen months (Fig. 3).

long axis of the bone; whereas in the tibia, fibula, and femur the stress is applied almost along the axis of the bone. This may be the reason for a clearly defined line of fracture in the metatarsals and ulna which is not seen in the tibia, fibula, and femur. The extensive periosteal stripping is unusual but it has been noted before (Kitchin and Richmond, 1945).

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ETIOLOGY OF PERONEAL SPASTIC FLAT FOOT

R. I. HARRIS and THOMAS BEATH, TORONTO, CANADA *

A type of rigid flat foot which is accompanied by contraction of the peroneal muscles has long been recognised. The etiology is obscure. Correction of the deformity seems to be prevented by tension of the peroneal muscles, and there has been wide acceptance of the thesis that the deformity is caused by peroneal muscle spasm induced by painful stimuli arising from the tarsal joints. It has been assumed that these stimuli result from abnormal stresses thrown upon the tarsal joints by severe degrees of weak flat foot. The concept, therefore, has been that of a weak flat foot which originally was flexible but which was transformed later into a rigid flat foot by the development of peroneal spasm.

This theory does not explain all the features of peroneal spastic flat foot. In many cases it can be demonstrated by electromyographic studies that there is no spasm of the peroneal muscles; the peronei react in every way as do normal muscles. The apparent spasm, in reality, is an organic shortening of the muscles adaptive to long-continued deformity. If all possibility of peroneal spasm is eliminated by novocaine block of the peroneal nerve, by section of the peroneal nerve, by section of the peroneal tendons, or by anaesthesia supplemented with curare, the deformity still persists in many cases.

It is difficult to believe that peroneal spastic flat foot develops from flexible flat foot by reason of the stresses which fall upon the tarsal joints. Flexible flat foot is comparatively

FIG. 1

Calcaneonavicular bar (in this case synostosis calcaneonavicularis) which is sometimes the cause of rigid flat foot.

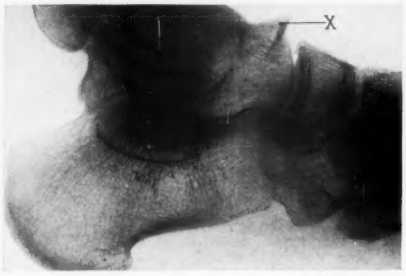

FIG. 2

Lipping of the talus in rigid flat foot almost always indicates a tarsal anomaly limiting subtalar movement and thus distorting talo-navicular movement

common in childhood, adolescence, and young adult life, and it is not at any time accompanied by peroneal spasm. On the other hand peroneal spastic flat foot is rare, and when it does occur it often dates back to early childhood; the foot has always been stiff. This suggests that it is a separate type of flat foot, probably congenital in origin, and rigid from the onset.

In 1921 an important contribution was made by Sloman. This was supplemented in 1927 by Badgley. Both authors observed that certain severe cases of the deformity were associated with a structural anomaly, namely fusion of the anterior process of the calcaneus to the navicular—coalescentia calcaneonavicularis, or calcaneonavicular bar (Fig. 1). Little attention has been paid to these important contributions. Lapidus (1946), in his extensive report, made no reference to them, nor did the papers he reviewed include any suggestion that rigid flat foot might be due to structural anomalies of the tarsus.

In this paper we shall show that most cases of so-called peroneal spastic flat foot are due to tarsal anomalies. The calcaneonavicular bar, described by Sloman and Badgley, is

* *Paper read at the combined meeting of the American, British, and Canadian Orthopaedic Associations in Quebec, June* 1948.

an occasional cause of the deformity. Much more frequently, however, the deformity is due to an anomaly which hitherto has been unrecognised by surgeons, though it has been recorded by anatomists, namely, coalescentia talocalcanea or talocalcaneal bridge. Both anomalies are occasionally present in the same foot, and it is possible that other tarsal anomalies may also lead to rigid flat foot.

INCIDENCE OF PERONEAL SPASTIC FLAT FOOT

Examination of 3600 Canadian males who presented themselves for enlistment in the Canadian Army showed that seventy-four had peroneal spastic flat foot—an incidence of 2 per cent. This was one-third the incidence of flexible flat foot (217 cases—6 per cent.). There was one case of calcaneonavicular bar, revealed by radiographic examination (Fig. 1). It did not cause symptoms or interfere with training as a soldier. Peroneal spastic flat foot caused serious disability. It interfered with military training. In nearly all cases the lateral radiograph showed lipping of the superior margin of the head of the talus—an anomaly of particular significance which will be discussed later.

TARSAL ANOMALIES—THE CAUSE OF RIGID FLAT FEET

Two years ago, in developing a medial approach for the treatment of peroneal spastic flat foot by subtalar and talonavicular fusion, we noted a bridge of bone springing from the

FIG. 3

Radiographic projection necessary to reveal talocalcaneal bridge. The central X-ray beam is projected downwards and forwards at an angle of 45 degrees, through the heels which have been freed of the leg shadow by flexing the knees.

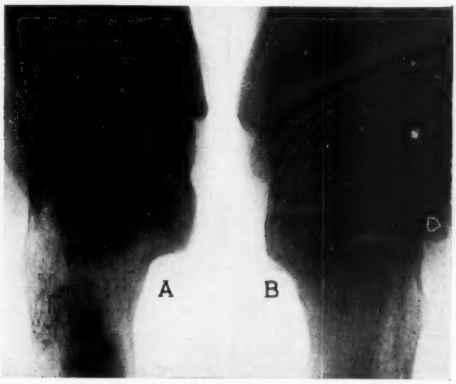

FIG. 4

Radiograph obtained by the technique depicted in Fig. 3, in a patient who had a talocalcaneal bridge on the left side (A). On the right side (B), which is normal, the joint between the sustentaculum tali and the neck of the talus can be seen.

medial surface of the talus, spanning the subtalar joint, and meeting a mass of bone from the medial surface of the calcaneus at the posterior end of the sustentaculum tali. Since then we have found this abnormality in twelve of the seventeen cases of peroneal spastic flat foot which have come under our care. The remaining five cases included three with calcaneonavicular bars and two of tarsal rheumatoid arthritis. In this small series, therefore, tarsal anomalies were the cause of deformity in 88 per cent. of cases: in more than two-thirds of the cases there was a talocalcaneal bridge; and in nearly one-fifth there was a calcaneonavicular bar.

Radiographic demonstration of talocalcaneal bridge—Failure to recognise this anomaly, and to associate it with peroneal spastic flat foot, must be attributed to the difficulties of radiographic visualisation. It is not seen in ordinary projections of the foot; a special projection is necessary if clear pictures are to be secured (Figs. 3 and 4).

In a normal foot this projection passes between the sustentaculum and neck of the talus so that the joint space is shown clearly; when there is talocalcaneal fusion the joint space is replaced by a bone bridge. A secondary change is seen in lateral radiographs, namely marginal lipping of the talonavicular joint on its dorsal surface (Fig. 2). This is present

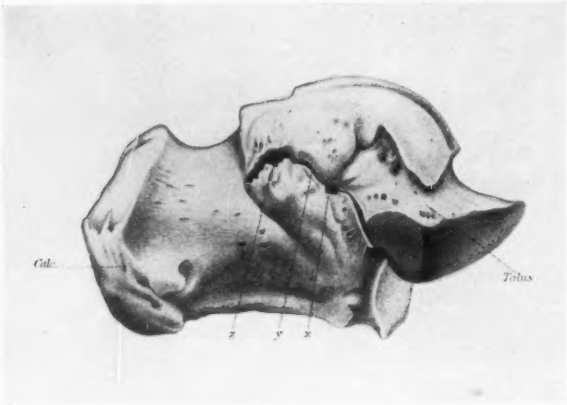

FIG. 5

Reproduction of Pfitzner's illustration of his case of talocalcaneal bridge which he described thus: "Coalescentia talocalcanea. Talus and Calcaneus in situ, medial view. *x*—opening of the anterior arm of the canalis tarsi (the posterior arm, not visible in this view, opens behind the syndesmosis). *y*—accessory joint between talus and sustentaculum. *z*—syndesmosis (coalescentia) between talus and posterior end of sustentaculum."

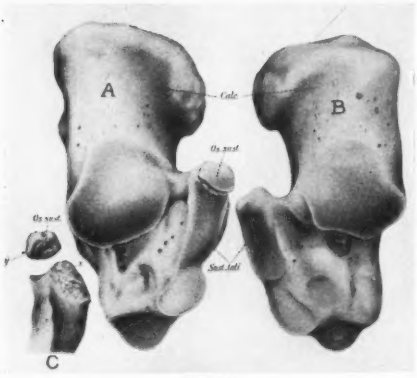

FIG. 6

Pfitzner's illustration described thus: "Os sustentaculi proprium, separate on the right side (A); fused with the sustentaculum on the left (B); dorsal view (C) sustentaculum and os sustentaculi to demonstrate the contact surface—X and Y."

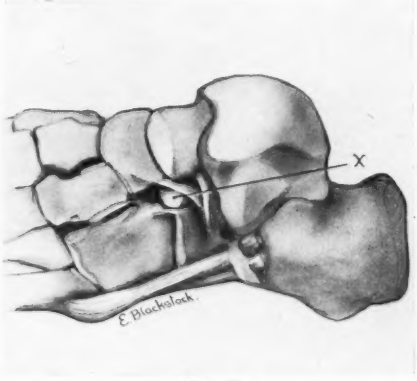

FIG. 7

Specimen of the rare accessory tarsal bone, calcaneus secundarius (marked X), which is the basis of calcaneonavicular bar. (From the anatomical museum of the University of Toronto, by courtesy of Professor J. C. B. Grant.)

to some degree even in children (Fig. 9). With advancing years the lipping becomes still more marked (Fig. 13). Such lipping on the dorsal margin of the talonavicular joint in a case of peroneal spastic flat foot is invariably associated with anomalies of the tarsal structure which limit movement of the subtalar joint—either a calcaneonavicular bar or, more commonly, a talocalcaneal bridge. The anchoring effect of these bone fusions deranges

the normal inversion-eversion movement of the subtalar and midtarsal joints and throws abnormal stresses upon the talonavicular joint, thus causing impingement of the articular margins and the development of osteophytes.

Descriptions of the talocalcaneal bridge by anatomists—Anatomists have been aware of this talocalcaneal bridge. The best account we have found is in Pfitzner's *Beiträge zur Kenntniss des Menschlichen Extremitätenskelets vii. Die Variationen in Aufbau des Fusskelets,* published fifty years ago. He reported two cases and added seven others from the literature. He noted variations including an accessory joint between the sustentaculum and talus (articulatio talocalcanea accessoria) a fibrous bond between the two bony masses (coalescentia talocalcanea) and bone fusion (synostosis talocalcanea). In several cases there was also synostosis calcaneonavicularis (calcaneonavicular bar). This combination existed in one of our cases. Pfitzner relates the anomaly to the accessory tarsal bone—os sustentaculi,

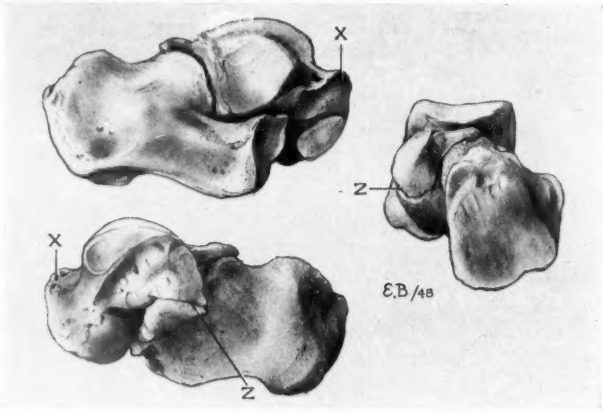

FIG. 8

Specimen of right talocalcaneal bridge (from the anatomical museum of the University of Toronto by courtesy of Professor J. C. B. Grant). It is exactly similar to the specimen illustrated by Pfitzner. Below—medial view showing syndesmosis between talus and posterior end of sustentaculum (Z), and lipping of the superior margin of the articular surface of the head of the talus characteristic of rigid flat foot due to tarsal anomalies (X). To the right—posterior view showing marked valgus tilt of the calcaneus.

occasionally found at the posterior end of the sustentaculum tali. Certainly this is the position of the mass of bone which spans the subtalar joint and fuses with the body of the talus. Pfitzner's illustration of one case of talocalcaneal bridge is reproduced in Fig. 5. Through the courtesy of Professor J. C. B. Grant we have been able to identify a similar case in the anatomical museum of the University of Toronto which is illustrated in Fig. 8.

Dwight (1907), from a study of the Harvard anatomical material, mentioned the occurrence of coalescentia talocalcanea. He quoted Pfitzner's observations and commented on page 17 of his monograph: "The first of these exceptional bones, the os sustentaculi, forming the hind end of the sustentaculum, is very uncommon. I have never seen it separate. It is of no practical importance *except as concerned in fusion of the astragalus and os calcis* and would be hard to show in an X-ray." On page 22 we may read: "Fusion of the astragalus and os calcis occurs at the posterior end of the sustentaculum and may be attributed to the os sustentaculi fusing with both bones. The bones may be firmly

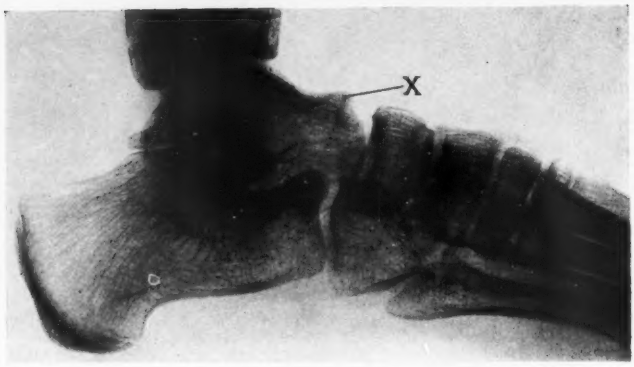

FIG. 9

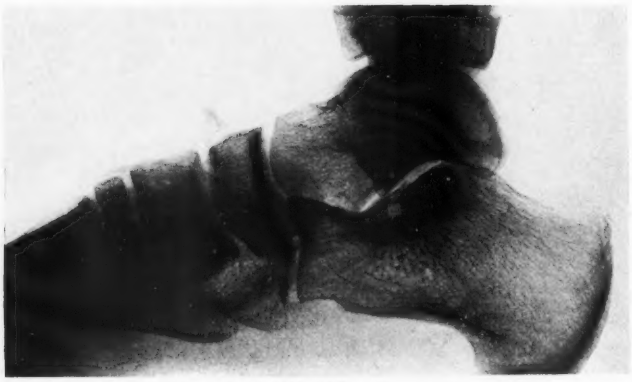

FIG. 10

FIG. 11

Osteoarthritic lipping in a thirteen-year-old child, demonstrating that structural changes due to rigid flat foot from tarsal anomalies may appear early in life. Fig. 9 shows a lateral projection of the involved left foot, the lipping of the head of the talus being marked X. Fig. 10 shows the normal right foot. Fig. 11 is the postero-superior oblique projection showing the talocalcaneal bridge on the left side (A) in contrast with the normal talosustentacular joint on the right side (B).

co-ossified or they may be united by gristle, the opposed surfaces showing the characteristic irregular finish. Either of these conditions is decidedly uncommon."

Nomenclature—A few words regarding nomenclature are necessary. Pfitzner's strict adherence to B.N.A. usage is precise and valuable. If the bone bridge is complete it is designated—synostosis talocalcanea. If the bridge is interrupted it is designated—coalescentia talocalcanea; this term may be further modified by the terms syndesmosis or synchondrosis to designate the type of tissue which fills the gap. There is need, however, for a simple all-inclusive title and we propose the term " talocalcaneal bridge." Similar words are used to describe fusion of the calcaneus and navicular, namely, synostosis calcaneonavicularis and coalescentia calcaneonavicularis. The all-inclusive term is " calcaneonavicular bar."

TYPES OF PERONEAL SPASTIC AND RIGID FLAT FOOT

The term peroneal spastic flat foot is often applied indiscriminately and inaccurately to certain rigid flat feet which arise from quite different causes. There are at least three such entities and there may be others. Two are related to each other, since in each there is anomaly of tarsal structure with fusion of the calcaneus to the navicular, or to the talus. In these cases there is a deformed rigid foot without peroneal spasm; the peroneal muscles are shortened adaptively in consequence of valgus deformity. The third entity is inflammatory arthritis of the tarsal joints with reflex peroneal muscle spasm which twists the foot into valgus. In the early stages this may fairly be called peroneal spastic flat foot, though it would be more informative to emphasize the nature of the pathological process which gives rise to the spasm rather than the mechanism whereby deformity is produced. The term peroneal spastic flat foot should be abandoned in favour of more precisely descriptive designations of the different varieties of the deformity. For that purpose, a detailed description of the clinical picture of the three different types is necessary.

1) Rigid flat foot due to talocalcaneal bridge (Synostosis talocalcanea or coalescentia talocalcanea)—In this tarsal anomaly there is fusion of the accessory os sustentaculi to the talus and calcaneus. The complete form is represented by a bone bridge arising from the calcaneus immediately behind the sustentaculum, spanning the subtalar joint and fusing with the body of the talus (synostosis talocalcanea). The bone bridge is not always complete, in which case there may be a fibrous bond between the calcaneus and talus (syndesmosis talocalcanea) or a cartilaginous bond (synchondrosis talocalcanea). The bridge may be a synostosis in one area, and a syndesmosis or synchondrosis in another; or the two masses may establish contact by means of an accessory joint (articulatio talocalcanea accessoria). In every variation of the anomaly, except the last, there is some fixation of the talus to the calcaneus; it is complete if synostosis is present, and nearly complete if the lesion is a syndesmosis or synchondrosis. This complete or incomplete fixation of the talus to the calcaneus interferes with normal freedom of inversion-eversion movement, and movements of the talonavicular joint are distorted. In consequence there is impingement of the articular margins of the talus and navicular, and very characteristic osteoarthritic lipping develops on the supero-lateral margin of the head of the talus (Fig. 8).

For reasons which are obscure, the talocalcaneal bridge forces the calcaneus into valgus and often produces marked deformity. Commonly the deformity is limited to a valgus tilt of the heel without depression of the longitudinal arch, but severe deformities combine valgus at the midtarsal joint with valgus of the heel. Our impression is that the most severe deformities are associated with synostosis rather than coalescentia talocalcanea. There may be no parallel between deformity and symptoms. Patients who have synostosis may have surprisingly few symptoms even when deformity is great.

Since the basis of this rigid flat foot is a congenital tarsal anomaly it is first observed in early life. It may well be present from birth, but it is seldom detected until the child begins to walk. In such cases the diagnosis of congenital club foot of the calcaneovalgus type is often made. The true lesion is not revealed in routine radiographic projections but it can be visualised by special projections (Figs. 3 and 4).

2) Rigid flat foot due to calcaneonavicular bar (synostosis or coalescentia calcaneonavicularis)—This type of flat foot is due to fusion of the anterior process of the calcaneus to the navicular (Fig. 16). The fusion may be a complete bone bridge (synostosis) or there may be a dense fibrous band (coalescentia). The anomaly is believed to result when the rare accessory tarsal bone, calcaneus secondarius, fuses to the calcaneus and the navicular. When bone fusion is not complete it is often possible to recognise that the calcaneus secundarius has fused to the calcaneus or sometimes to the navicular.

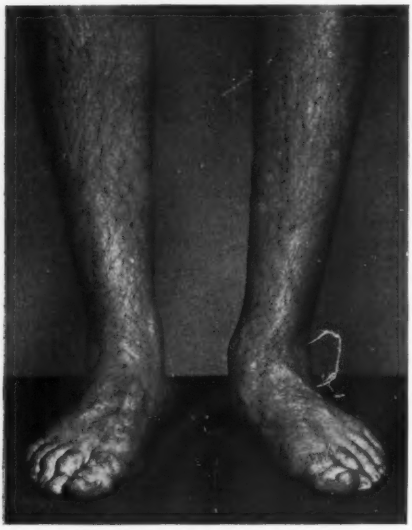

FIG. 12

Feet of the patient whose radiographs are reproduced in Figs. 13–15.

A calcaneonavicular bar, by fixing the calcaneus to the navicular, restricts and distorts inversion-eversion movements. The foot is rigid, and abnormal stresses are thrown on the midtarsal joint. The clinical picture varies greatly. Unlike the talocalcaneal bridge, which probably always causes deformity and disablement, the calcaneonavicular bar may cause no deformity and no disability. This is particularly true when there is fusion by bone. The one instance of calcaneonavicular bar found in the Canadian Army Foot Survey was such an example: there was no deformity and no disablement; nor did it interfere with military training.

When there are symptoms, they may be grouped into well-defined syndromes. 1) There may be long standing deformity and disablement dating back to early childhood. The deformity is severe and it is associated with persistent pain and weakness, thus resembling cases of talocalcaneal bridge. This is the type of case which was described by Sloman and Badgley. 2) There may be no deformity and no disability until the patient sustains a severe wrenching injury which gives rise to persistent pain and weakness. Such cases are due to avulsion of the calcaneus from the navicular at the fibrous bond. During the acute phase there may be peroneal spasm with rigidity of the foot. The peroneal spasm and the fixation subside rapidly with rest but they may recur if early exercise is permitted. The symptoms tend to persist. 3) There is some evidence to suggest that the calcaneonavicular bar may be fractured and even that such fractures may unite.

3) Arthritic flat foot with peroneal spasm—When rheumatoid arthritis affects the tarsal joints it induces peroneal spasm with resulting valgus deformity. In the later stages there is permanent damage of the joints with fixation in the deformed position. A clear distinction should be drawn between these cases and those with tarsal anomalies. This group of foot deformities must be recognised as part of the problem of arthritis. It would be desirable to recognise their true nature and use the accurate designation "arthritic flat foot with peroneal spasm."

FIG. 13

FIG. 14

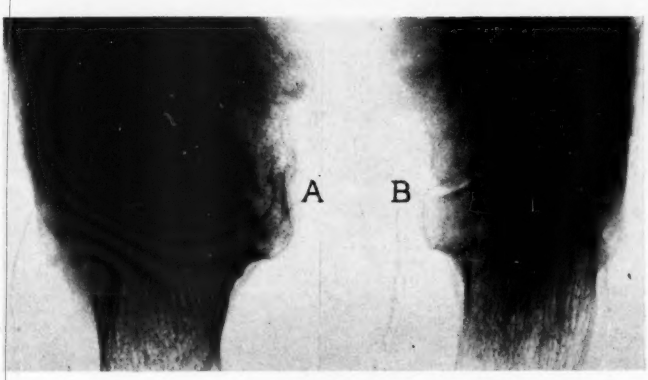

FIG. 15

A twenty-six-year-old woman who had a left rigid flat foot from infancy with marked valgus of the heel (Fig. 12) but without great flattening of the longitudinal arch. Fig. 13 is a lateral projection of the involved left foot showing severe lipping of the talonavicular joint. Fig. 14 shows the normal right foot. In Fig. 15 the postero-superior oblique projection shows a talocalcaneal bridge on the left side (A) and a normal talosustentacular joint on the right side (B).

FIG. 16

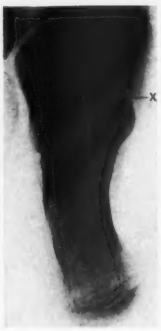

FIG. 16A

FIG. 17

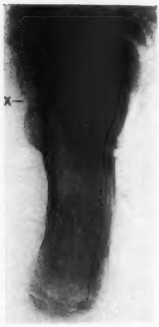

FIG. 17A

An example of calcaneonavicular bar, complete on the right side (Fig. 16—synostosis calcaneonavicularis) and incomplete on the left side (Fig. 17—syndesmosis calcaneonavicularis). The patient was a fifteen-year-old boy with moderately severe deformity and increasing disabling symptoms worse on the left side than on the right. In each foot the postero-superior oblique radiograph (on the right) shows a normal talosustentacular joint with no talocalcaneal bridge.

FIG. 18

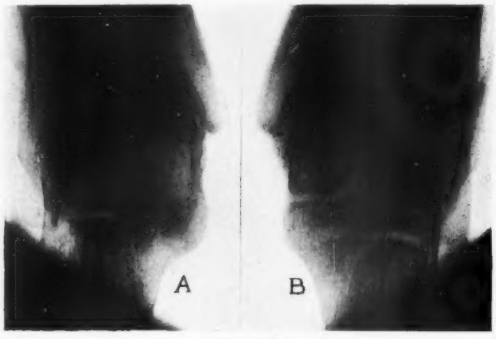

FIG. 19

Severe congenital calcaneovalgus deformity of the left foot (Fig. 18), treated for twelve years by manipulations and plasters. Postero-superior oblique radiographs of the feet (Fig. 19) show a talocalcaneal bridge in the left foot (A) and a normal talosustentacular joint in the right foot (B). The bridge was demonstrated at operation; the deformity was corrected and the subtalar and talonavicular joints fused.

Congenital calcaneovalgus—The conception that most cases which are described as peroneal spastic flat foot are due to congenital anomalies of tarsal structure has led us to recognise that some, and perhaps all, cases of congenital calcaneovalgus are in reality severe examples of deformity due to a talocalcaneal bridge, sufficiently conspicuous to be recognised at birth, and totally unrelated to congenital talipes equinovarus. Review of one of our cases in the light of newly acquired knowledge revealed synostosis talocalcanea by radiography (Figs. 18 and 19) and this was confirmed at operation. Badgley records a similar case due to a calcaneonavicular bar. We are inclined to believe that tarsal anomalies may prove to be the cause of most cases of congenital calcaneovalgus.

TREATMENT OF PERONEAL SPASTIC FLAT FOOT

Treatment of cases with tarsal arthritis—In general discussion of treatment, arthritic cases must be separated from tarsal anomalies. Treatment in the arthritic case must be directed to the systemic disease of which the foot problem is a local manifestation.[4] Systemic treatment of the disease can be supplemented by local measures to correct or prevent deformity, and to protect the foot from further damage. Treatment of these cases is largely a medical problem but certain orthopaedic procedures can be valuable adjuncts. Of these the most important are: manipulation under anaesthesia to correct deformity; plaster casts to maintain correction; and foot supports of the Whitman type.

Treatment of rigid flat foot with tarsal anomalies—Rigid flat feet due to tarsal anomalies require entirely different treatment. Generally speaking, the deformity and disablement will not be corrected except by surgical measures. We are not impressed by the operation of removing the talocalcaneal bridge, or dividing the calcaneonavicular bar, in an effort to restore normal mobility. Better correction of deformity and better function is obtained by fusion of the subtalar and talonavicular joints, and this is the procedure we advocate when the disability is severe.

Treatment in childhood—Arthrodesis of the tarsal joints should not be undertaken in early childhood. If possible it should be postponed until late adolescence. Some plan of management must therefore be established which will tide the patient through childhood. Repeated manipulations under anaesthesia with immobilisation in the corrected position in plaster give the best results. When deformity is less severe, much can be done by consistent support of the foot with Whitman plates.

Operative treatment—The only surgical procedure we have found to be of value is arthrodesis of the subtalar and talonavicular joints. This is best accomplished through a medial approach which gives direct access to the talocalcaneal bridge and to the calcaneonavicular bar when one is present. The synostosis must be removed in order to free the calcaneus from the talus. Correction of the deformity is then accomplished by remodelling the opposed surfaces of the talus and calcaneus at the subtalar joint. If deformity is severe it may be necessary to make a separate lateral incision through which to lengthen the peroneal tendons and even the peroneus brevis and outer slips of the extensor digitorum brevis. The tubercle of the navicular is removed, and the navicular and head of the talus are denuded of cartilage. Cancellous bone is packed into the field of operation and when deformity has been corrected the wound is closed and plaster is applied.

SUMMARY

1. Peroneal spastic flat foot is a term loosely and often inaccurately used to describe rigid valgus feet developing from widely different causes.

2. The most common causes are two anomalies of the bones of the tarsus—the calcaneonavicular bar, and the talocalcaneal bridge. The first was described in 1921 by Sloman and in 1927 by Badgley; the other is described for the first time in this paper as an etiological

factor in rigid flat foot though it has been recognised by anatomists for fifty years as a skeletal variation. The term peroneal spastic flat foot, as applied to these cases, is inaccurate since there is no spasm of the peroneal muscles. The deformity is a fixed structural deformity due to anomalous bone structure, and the apparent spasm of peroneal muscles is in reality an adaptive shortening. A better term would be rigid flat foot due to talocalcaneal bridge or calcaneonavicular bar.

3. The smaller group of patients who suffer from inflammatory lesions of the tarsal joints, chiefly due to rheumatoid arthritis, do in fact develop valgus deformity from peroneal spasm. The resemblance between the two groups is superficial and it is limited to the apparent similarity of the deformity. Though it might be justifiable to designate this type as peroneal spastic flat foot, it would be better to use the more accurate title—arthritic flat foot with peroneal spasm.

4. Lipping of the upper margin of the talonavicular joint strongly suggests the existence of one or other of the *congenital* anomalies. Both anomalies are visualised only by special radiological projections.

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DENERVATION OF THE ELBOW JOINT FOR THE RELIEF OF PAIN

A Preliminary Report

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Few accurate studies have been made of the pain patterns and pathways of articular structures. In the synovial membrane there is a fine plexus of delicate nerve fibrils with end-bulbs just beneath the free surface. Intra-articular sensation is recorded through this network, and impulses reach the neighbouring main nerve trunks along small branches. In addition to this purely sensory articular mechanism, there is an important auxiliary sensory defence, designated as " deep " sensation, which has to do chiefly with recognition of movement and appreciation of position, but which includes also some pain appreciation. Adjacent muscles serve as accessory ligaments and derive their nerve supply from the same sources as the articular structures. Nerve fibrils filter into juxta-articular ligamentous attachments along vascular channels and reinforce both superficial and deep pathways.

Impulses arising from all these sources undergo regrouping in their passage to the central nervous system. Impulses from both deep and superficial origins which are capable of provoking pain are screened by specific receptors associated with the secondary tracts. This leads to a grouping and gathering together of pain stimuli which then pass up the spinal cord in a separate tract. The same mechanism applies to thermal and tactile appreciation. In this anatomical pattern lies the explanation for the profound changes in joints which may occur in disease of the posterior columns. Obliteration of appreciation of all protecting impulses exposes joints to continued and uncontrolled injury. On the other hand, when the " superficial " system is involved alone, as in the case of division of a peripheral nerve, there remains a line of protection in the deep system. Loss of deep sensibility, and appreciation of joint position and vibration is prominent in tabes dorsalis; whereas appreciation of deep pressure and joint movement is characteristic of peripheral nerve injury. In supervising a group of more than one thousand peripheral nerve injuries, the author did not see one example of the characteristic ablative arthropathy of tabes and syringomyelia.

Surgical measures adopted for the relief of pain from articular structures have included operations on the spinal cord and sympathetic system as well as on peripheral nerves. Tractotomy is a formidable procedure which is not always controlled accurately; the results are uncertain, and the complications may be serious. Attacks on the sympathetic system do not reach the seat of the disturbance. Complete section of peripheral nerve trunks, producing motor and sensory loss, leads to complications such as trophic changes which are even more serious than the disturbance for which the operation is done. It is apparent from these considerations that neurosurgical efforts to relieve joint pain are best directed to the peripheral or articular mechanism. This involves understanding of the physiological limitations of such procedures, and accurate knowledge of the peripheral neuro-anatomy.

INNERVATION OF THE ELBOW JOINT

In studying a group of nerve injuries the author has had the opportunity of making observations on the pattern of innervation of certain joints. Study of the innervation of 152 elbow joints from the ulnar, median, radial, and musculocutaneous nerves, is summarised

* *From a Paper read at the Joint Meeting of the American, British, and Canadian Orthopaedic Associations in Quebec, June* 1948.

in Table I. The largest and most constant contribution comes from ulnar nerve; as a rule there is a single stout articular twig; often two twigs can be identified; occasionally there are several. The median contribution is not nearly so constant, or so large, as that of the ulnar nerve and it shows some degree of reciprocity with the ulnar supply. When there is a small single ulnar twig there is likely to be a large median contribution; where there are multiple ulnar twigs the median supply is meagre. The musculo-cutaneous nerve, while it is in the process of extending to more superficial structures, occasionally sends a stout branch directly down into the joint, and frequently many fine twigs pass to the periarticular structures. The radial nerve at the front of the joint seldom contributes a good branch, but as it becomes associated with the radial and interosseous arteries, nerve twigs accompany branches of the vessels to the region of the radio-ulnar joint. On the posterior aspect, the branch from the radial nerve to the anconaeus muscle terminates in a small plexus in or beneath the muscle, mingling with a group of small vessels. This network lies directly over

TABLE I

Nerve	Number of operations	No branches	One branch	Two or more branches
Ulnar	58	2	42	14
Median	28	17	10	1
Radial	32	28	4	0
Musculocutaneous . .	18	14	4	0
Anconaeus branch . .	16		Constant twigs	

the radio-ulnar joint, and twigs pass from the plexus to the joint. This contribution shows much variability. Sometimes nerve filaments cannot be traced through the anconaeus, but they have been seen often enough to make it desirable to expose this area in attempting denervation of the elbow joint.

Branches from the main nerve trunks to the elbow joint follow a constant pattern. Articular twigs are supplied before muscular branches. In stripping nerves across the joint, when motor branches are once reached it is unlikely that further branches to the joint will be found.

APPLICATION OF NEURECTOMY TO THE ELBOW JOINT

There is much interest in peripheral articular denervation as applied to the elbow joint which is easily exposed and is a non-weight-bearing joint. In cases of post-traumatic arthritis, and osteoarthritis, the operation seems reasonable as an alternative to arthrodesis or arthroplasty. In a young labouring man, with extensive articular damage, arthrodesis may be the procedure of choice. Nevertheless, many patients are reluctant to accept stiffness of the elbow and are eager to cling to mobility, no matter how small the range. Arthroplasty is also a possibility, but it may leave an unstable limb which is unsuitable for heavy work. Furthermore, in older patients, less extensive operative procedures are preferable; it is relief of pain which is paramount and rugged use is less essential.

Technique of operation—The joint is approached through three incisions. The first is along the border of the biceps, mid-way between the tendon and the medial epicondyle. Through this incision both median and ulnar nerves are exposed. The branches are identified about two inches above the joint and are traced to the elbow. It is often advisable to transplant the ulnar nerve from the groove behind the medial epicondyle to the front of the joint, particularly when there is valgus deformity with symptoms of ulnar neuritis. There may be one, two, or three articular branches; each is severed. Branches from the median nerve are

also cut. The trunks are stripped from their moorings well above and well below the joint so that all filamentous twigs, as well as definite branches, are divided.

An incision of similar length is made on the lateral side of the joint mid-way between the biceps tendon and the lateral epicondyle. In the interval between the biceps and brachioradialis muscles the musculocutaneous nerve will be found. This is stripped across the joint and articular twigs are crushed with mosquito forceps. As the nerve branches are exposed they are pinched gently: if there is a motor response they are spared; if not, they are divided. Deeper in this interval the radial nerve can be identified. It is traced well down towards the bifurcation, and any branches which are found extending to articular structures in company with small arteries are severed.

FIG. 1

FIG. 2

Fig. 1 shows the incisions used for approach to the ulnar, median, radial and musculo-cutaneous branches. Fig. 2 shows the incision used for exposure of the branches to the anconaeus.

The operation is completed by a small incision over the anconaeus muscle, just behind the lateral epicondyle. The nerve filaments, accompanied by a small vascular plexus, are identified running at right angles to the muscle fibres. As a rule, the whole neurovascular bundle is cut. Sometimes the under surface of the anconaeus is stripped with scissors so that fine, penetrating twigs are severed from the subjacent capsule.

Throughout the procedure emphasis must be placed on the stripping of nerves, rather than on tedious search for individual articular branches. The anatomical law that articular branches are supplied first, and motor branches only after that, is dependable. No damage

FIG. 3
Case 1
Gunshot wound of elbow

FIG. 4
Case 2
Osteomyelitis lower end humerus

FIG. 5
Case 3
Gunshot wound of elbow

FIG. 6
Case 4
Monteggia fracture of forearm

FIG. 7
Case 5
Compound fracture humerus

FIG. 8
Case 6
Gunshot wound of elbow

FIGS. 3–13

Cases of elbow injury for which denervation of the joint has been used for the relief of pain.

is done by "stripping." Furthermore, the most proximal muscle supplied by a main nerve trunk has often a dual or triple innervation so that even the first motor branch may be sacrificed without significant damage.

FIG. 9
Case 7
G.S.W. elbow

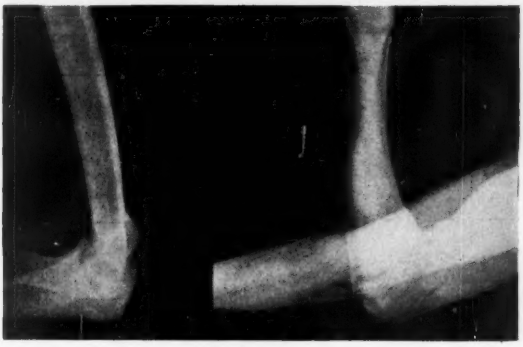

FIG. 10
Case 8
Rheumatoid Arthritis of elbow

FIG. 11
Case 9
G.S.W. elbow

FIG. 12
Case 10
G.S.W. elbow

FIG. 13
Case 11
Compound fracture

RESULTS OF DENERVATION OF THE ELBOW JOINT

This operation has been carried out in eleven patients who were available for follow-up study. In each case the patient complained before operation of pain in the elbow, aggravated by activity, and persisting at night even to the point of interfering with sleep. Radiographic examination showed varying degrees of post-traumatic osteoarthritis.

The longest period of post-operative observation has been twenty-one months; and the shortest period four months. The results of denervation have been similar in all cases. Immediately after operation, upon recovery from the anaesthetic, there was a changed sensation in the elbow. There was sometimes pain in the region of the incisions but the dragging and aching sensation had disappeared. When the wounds were healed, sharp and stabbing pain on movement was no longer experienced. The patients were able to sleep undisturbed. Upon resuming activity, carrying the arm at the side was no longer painful; and whatever the previous range of movement may have been, it was regained without

TABLE II

Case No. Name	History and duration of symptoms	Age	X-ray changes	Diagnosis	Length of time since operation	Result and rehabilitation
1 A. F. (Fig. 3)	G.S.W. elbow, 1944; pain and limitation of movement; 3 years	29	Marked	Post-traumatic osteoarthritis	21 months	Relief of pain through retained range of movement. Returned to moderately strenuous manual activity involving continued use of right arm.
2 J. C. (Fig. 4)	G.S.W. elbow, 1944; osteomyelitis lower end of humerus; pain and limitation of movement; 18 months	38	Marked	Osteomyelitis of humerus. Post-traumatic arthritis	21 months	Complete relief of pain through retained range of movement. Returned to his occupation as a polisher
3 W. B. (Fig. 5)	G.S.W. elbow, 1944; osteomyelitis and mal-union of humerus; effusion of left elbow; 6 months	29	Minimal	G.S.W. elbow. Osteomyelitis humerus	9 months	Freedom of pain through 90 degrees of movement. Returned to former occupation
4 F. J. S. (Fig. 6)	Old Monteggia fracture of forearm; increasing pain and stiffness in elbow; 2 years	54	Minimal	Old fracture ulna. Osteoarthritis of elbow. Incomplete delayed ulnar palsy	7 months	Relief of pain through retained range. Improvement but not complete recovery of ulnar paresis. Returned to previous occupation which did not involve heavy work
5 C. W. F. (Fig. 7)	G.S.W. elbow; compound fracture of humerus; 2 years	32	Marked	Post-traumatic osteoarthritis left elbow	7 months	Freedom of pain through retained range. Returned to occupation not involving strenuous use of left arm
6 A. A. (Fig. 8)	G.S.W. elbow, 1917; working as fireman until 6 months ago when persistent pain seriously limited activities	54	Marked	G.S.W. elbow. Post-traumatic osteoarthritis	17 months	Immediate relief of pain through previous range of movement. Pain at extremes of flexion and extension. Residual tenderness over ulnar nerve. Returned to former occupation
7 W. A. G. (Fig. 9)	G.S.W. compound fracture of right humerus. Recurrent osteomyelitis; 2 years	56	Minimal	G.S.W. humerus. Recurrent osteomyelitis of humerus	7 months	Improvement, but not complete relief of aching pain previously present in elbow. Returned to former occupation as a painter
8 D. H. (Fig. 10)	Recurrent attacks of pain, swelling and limitation of movement in both elbows, left worse than right; 5 years	53	Marked	Rheumatoid arthritis	13 months	Complete relief of pain and increased movement for 6 months. Symptoms returned after 8 months necessitating arthrodesis. Returned to heavy work as millwright.
9 R. E. F. (Fig. 11)	G.S.W. elbow, 1944; 6 months	24	Marked	Post-traumatic osteoarthritis of elbow. Ulnar nerve paralysis	4 months	Relief of pain through limited range of movement. Returned to clerical occupation
10 W. R. H. (Fig. 12)	G.S.W. elbow, 1942; 3 years	27	Minimal	Post-traumatic osteoarthritis of elbow	4 months	Relief of pain through range of movement. Discarded electric pad worn continuously at night. Returned to clerical work
11 M. T. (Fig. 13)	Old compound fracture of elbow; persistent pain after recent fall	39	Marked	Post-traumatic osteoarthritis of elbow	6 months	Relief of pain except at extremes of range. Returned to duty as a nurse

discomfort. Forced movement, particularly at the limit of the range, caused discomfort which was not the same as before and was described as " stiffness " but without acute pain. In cases where there was limitation of movement by a bone block, passive manipulation caused discomfort at the limits of flexion and extension movements, but no such discomfort accompanied active and controlled use of the limb. In all cases but one, improvement was maintained and the patients went back to their former occupations. The exception was a man who for six months gained sufficient relief to return to work as a machinist, but then came back with a painful, swollen, and inflamed joint. There were similar symptoms in the opposite elbow. Sections of synovium taken at the time of arthrodesis demonstrated an acute, almost pyogenic-like, reaction, and the diagnosis of rheumatoid arthritis has been established (Case 8).

CONCLUSIONS

1. A method of denervating the elbow joint, based upon observations on the articular branches of the main nerve trunks, is presented.

2. In a small group of cases with post-traumatic arthritis and osteoarthritis, relief of pain and restoration of painless movement has been gained.

3. There was recurrence of pain after six months in one patient with acute rheumatoid arthritis; in such cases denervation is not recommended until further study is completed.

4. Denervation must be as complete as possible and full exposure with stripping of nerve trunks is recommended. There have been no complications.

5. The results in this small series of cases are encouraging, but patients should be warned that there will be no significant increase in the range of movement, and that a normal joint is not to be expected.

6. Articular neurectomy is still on trial. If the limitations are recognised, the procedure may have a useful place in the relief of pain in the elbow joint.

DISCUSSION

Dr J. Albert Key (St Louis, Missouri): I was interested in reading Dr Bateman's paper and a little apprehensive about trying his operation. Now that I have seen his movie, and noted the ease with which these nerves are picked up by him, I think that some day I may try it, provided that I get a suitable case. But I do not recall having seen a case in which I would advise it. Pain is not a prominent feature in traumatic or hypertrophic arthritis of the elbow joint and it can usually be relieved by a simple operation such as resection of the head of the radius. There may be a field for this procedure of denervation in rheumatoid arthritis but I would need to know more about the end-results before advising it. Do the nerves regenerate, and is there then recurrence of pain? Are we going to have neurotrophic joints? Over a good many years I have performed obturator neurectomy in an effort to relieve pain in the hip. That operation removes only part of the nerve supply of the hip joint, and there have been no neurotrophic disturbances; but I believe that, if you take all the nerves, there may be a possibility of neurotrophic joints resulting. I hope that we may have another report within a few years showing whether or not there have been trophic changes as a result of complete denervation, and whether or not relief of pain has been permanent.

Dr James E. Bateman (Toronto, in reply): I can assure you that the danger of doing damage to the nerve trunks is small. There have been no complications from exposure and stripping of nerves across the joints; there is a good margin of safety. The possibility that neurotrophic joints may develop cannot be answered from a series so small as this, and from a follow-up study of so short a duration; but here again there is a wide margin of safety. The profound disturbance of sensory appreciation which occurs in posterior column disease is an entirely different entity as compared with denervation by this technique. Sensation from joints is mediated by sensory endings in the synovium, but there is an important second line of protection from the juxta-articular branches which filter into the area along muscle and tendon attachments. In posterior column disease, both superficial and deep sensations are obliterated; in this operative denervation it is only the superficial sensation which is interrupted. I cannot finish without expressing the appreciation, and indeed the thrill, I have experienced in joining the swelling ranks of prominent contributors who have been subjected to the kindly and constructive criticisms of Dr Key.

ISCHIO-FEMORAL ARTHRODESIS

H. A. Brittain, Norwich, England *

Accurate diagnosis has disabused our minds of the notion that it is possible to preserve mobility of the hip joint after tuberculous infection. At present, arthrodesis is the accepted form of treatment, and for joints which have been disorganised by disease it will probably remain so, though future developments in antibiotics may change this conception.

Ischio-femoral arthrodesis offers certain advantages over the various types of ilio-femoral arthrodesis. It is not suggested that this is the only operation by which to fuse a diseased hip, but it is suggested that it may be performed with success more often than any other. Ischio-femoral fusion may not, however, be feasible in every patient with a tuberculous hip. The ischium is a more rare site for extension of disease than the ilium, but it is occasionally involved, and a graft which is placed in a tuberculous area will probably fail. The graft may be able to traverse the diseased area and find a firm seat in healthy bone at each end, thus immobilising the joint for sufficient time to allow the disease to heal, but it will probably be eaten into and sustain fracture. Nevertheless, a graft in compression has more chance of uniting after fracture than a graft in tension, which has little or none.

Fig. 1

The area of old disease is outlined with a pencil and an endeavour is made to keep outside this area during the operation.

It is essential, therefore, to visualise the disease and the patient as a whole, to consider the form of arthrodesis which is most likely to succeed, and to decide at what stage, and at what best time, to perform the arthrodesis. It is now my custom to outline with a pencil the area of disease shown in the X-ray, and to try to keep outside this area in the course of the operation. If an ilio-femoral arthrodesis appears to offer a better chance of healing, then I carry this out. It is to be recognised, however, that the osteotomy performed in an ischio-femoral operation confers a unique advantage on the tuberculous hip, unlike other joints, in that the disease can be short-circuited and changed from the serious problem of joint disease to the less serious one of bone disease.

Stages of the operation—1) The patient having been placed on an orthopaedic table with his feet attached to the foot pieces and with the limbs in slight traction, two Michel clips are placed over the front of the hip joint. A calibrated guide is inserted on the antero-inferior aspect of the shaft and neck of the femur. An X-ray photograph is taken. An orthopaedic table is used so that there will be no pressure from behind which might press the sciatic nerve forwards against the neck of the femur.

2) While the photograph is being developed, a tibial bone graft is cut. I prefer to take it from the affected limb in order that the patient may have at least one sound limb upon which to walk when he is convalescent. It is essential to cut a wide tibial graft. The whole basis of the operation of ischio-femoral arthrodesis is the use of a wide tibial graft, which is more

* *Paper read at the combined meeting of the American, British, and Canadian Orthopaedic Associations, Quebec, June* 1948.

FIG. 2

Theatre radiograph of clips fixed on the skin, and of the calibrated guide in the bone.

FIG. 3

Theatre radiograph of the drill in position, through the femur into the ischium.

FIG. 4

Theatre radiograph of the chisels in situ. There is evidence of ischial penetration at the point of the chisels.

FIG. 5

Theatre radiograph of the graft in situ. The outer surface of the trochanter has been fragmented; the shaft is being displaced inwards.

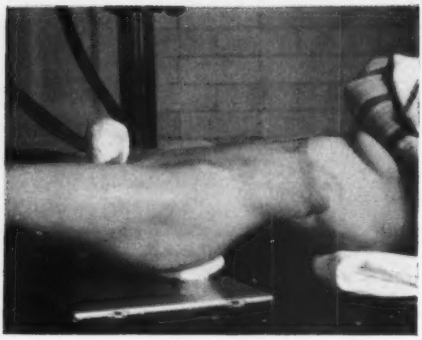

FIG. 6

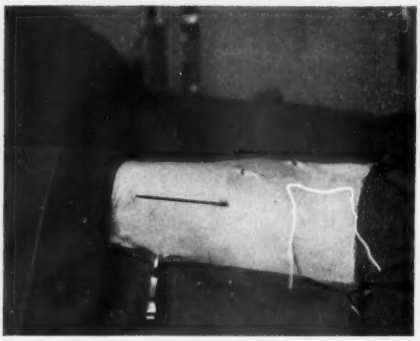

FIG. 7

FIG. 8

FIG. 9

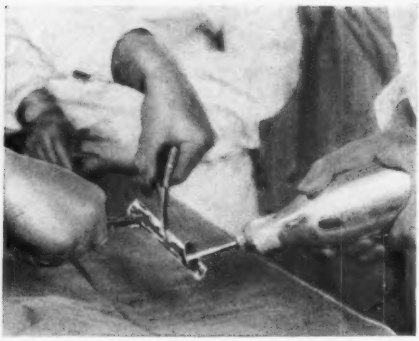

FIG. 10

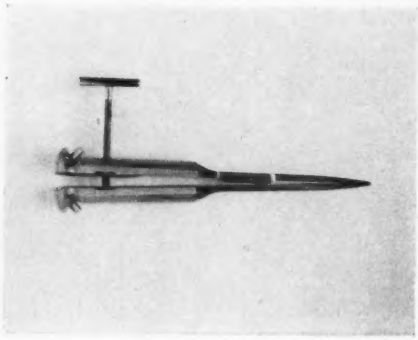

FIG. 11

Fig. 6 shows the patient on an orthopaedic table with cassette in position; note that there is no pressure from behind, displacing the sciatic nerve forwards. In Fig. 7, two Michel clips have been fixed, one over the greater trochanter and one on the middle point of the line from anterior superior iliac spine to the symphysis pubis; a calibrated guide has been passed in front and below the femoral neck. Figs. 8 and 9 show the graft being cut from the whole width of the tibia including the postero-medial and postero-lateral borders. One end of the graft is then cut to the shape of a chisel (Fig. 10). Fig. 11 shows the twin chisels, one with a ridge and shoulders to receive the other; they can be separated by the screw so that the cleft in the ischium is widened; each has a round projection so that it can be tapped out with a punch.

FIG. 12

FIG. 13

FIG. 14

FIG. 15

FIG. 16

FIG. 17

The drill is passed through the femur into the ischium (Fig. 12). When the position has been verified radiographically the osteotomy is started (Fig. 13). *If the posterior limit of the chisel is in front of the posterior margin of the greater trochanter, and the chisel is kept in the horizontal plane, the sciatic nerve cannot be struck.* Fig. 14 shows the chisels being separated by means of a special screw, so that the cleft in the ischium is made wide enough to receive the graft. The male chisel is then tapped out (Fig. 15). The greater trochanter is hooked up with a retractor and the graft is introduced along the female chisel (Fig. 16). The graft is punched home (Fig. 17).

certain to engage in bone in the ischium, though not necessarily in the tuber ischii. One may aim at a large target with a small arrow, but here one is aiming at a small target with a large bludgeon, and if any part of the bludgeon hits the target, success is probably assured. At first it is difficult to cut a graft which includes the postero-lateral and postero-medial borders of the tibia, but with practice this becomes simple. An additional advantage is that, since the width of the tibia has been decreased, the periosteum may be sutured without tension and the haematoma is enclosed, thus encouraging regeneration of the bone. After the graft has been taken it is shaped with the electric saw so that one end resembles a chisel.

3) A curved incision with the convexity passing upwards is made, starting one inch above the greater trochanter and finishing four inches distal to it. A straight incision is made down to bone through the vastus lateralis throughout the limits of the incision, and the

FIG. 18

Tuberculous hip, operated on at the age of fifteen years after twenty months of disease. Radiograph eight years after operation. Note the apparent reformation of a medullary canal in the graft.

shaft of the femur is cleared. A site for osteotomy is chosen, bearing in mind that the lower limit of the greater trochanter is a point which is easy to verify, and that the Michel clips are an additional guide.

4) A small hand-drill is introduced through the femur at an angle of 45 degrees in the coronal plane, aiming at one of the Michel clips. After the inner wall of the femur has been pierced there is lack of resistance until the ischium is struck. The position of the drill is verified by an X-ray photograph.

5) A subtrochanteric osteotomy is performed. Special chisels are used with a screw to separate them, one chisel with a slot and shoulders to receive the other. After the osteotomy has been performed by one chisel (the male) it is tapped gently inwards until it engages in the ischium. An X-ray photograph is then taken, and the female chisel is introduced below the first.

FIG. 19

Case illustrating the difficulty of placing the graft in the ischial bone cleft, unless special chisels are used.

FIG. 20

Man aged fifty-four years, with osteoarthritis of the hip joint. Graft well placed. Radiograph six months after operation.

FIG. 21

FIG. 22

Congenital subluxation of the hip joint with secondary arthritis, in a patient aged twenty-eight years. Fig. 21 is the radiograph taken six months after ischio-femoral arthrodesis, using a graft from the femur. Fig. 22 shows the same hip joint eight years later. Note, not only that the ischio-femoral fusion is sound, but that the hip joint is consolidated; no intra-articular operation was performed.

FIG. 23

Tuberculosis of the left hip joint in a patient aged twenty-three years. Ischio-femoral arthrodesis was performed in 1942. Note the porosis in the upper part of the femoral head, the femoral neck, and the greater trochanter, which are not now weight-bearing.

FIG. 24

Tuberculous hip, patient aged fifteen years. Four operations were needed before ankylosis was sound. The lower graft failed because it passed through the obturator foramen. The upper graft has fused. Remnants of other grafts can be seen.

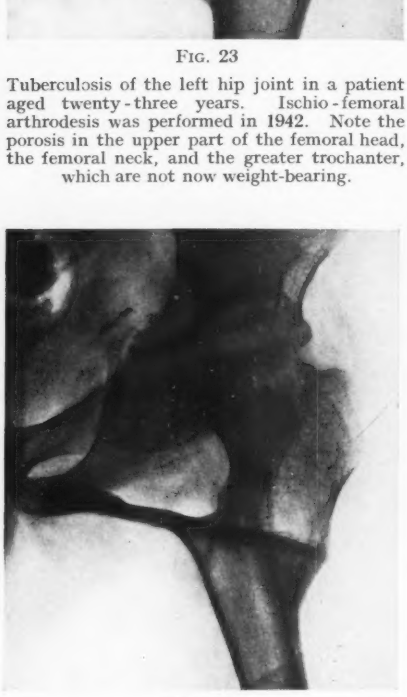

FIG. 25

Boy aged seventeen years with very active tuberculous disease of the hip. The graft was deliberately placed far from the hip joint into the ischial ramus. Radiograph one year after operation shows that the disease is healing.

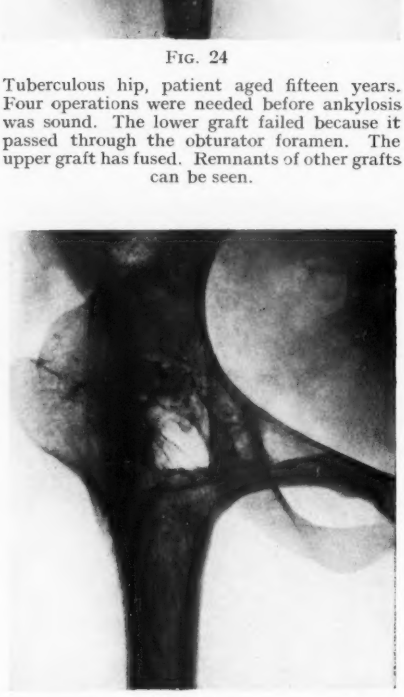

FIG. 26

Tuberculosis of the right hip joint, fused at the age of sixteen years after ten years of active disease. In this case the graft has united to the ascending pubic ramus. Radiograph nine years after operation.

6) The chisels are separated gradually by the introduction of a screw. By this means a V-shaped slot is made in the ischium; the entrance should be wider than the graft it is to receive. This overcomes one of the chief difficulties of the operation, namely, the finding of the cleft in the ischium by the graft.

7) The male chisel is then withdrawn. The greater trochanter is hooked upwards with a retractor, and the graft is tapped in along the female chisel. As it is tapped in, the female chisel is withdrawn. After the graft is felt to engage in the cleft in the ischium it is punched firmly home. *If any difficulty is met in finding the cleft, it may be felt by the finger. The*

middle finger is inserted in front of the greater trochanter and below the neck of the femur. In our last dozen cases we have had no difficulty in feeling the cleft.

8) The distal fragment of the femur is displaced inwards with a punch until it makes contact with the ischium, thereby supporting the middle part of the graft.

9) A double plaster spica is applied and maintained for at least four months, or until fusion occurs.

COMPLICATIONS

It has been stressed that this operation is difficult because it is blind. For this reason there must be a clear visual conception of the anatomy. The dangers are: *a*) striking the sciatic nerve; *b*) haemorrhage.

Striking the sciatic nerve—This should not occur. *If the posterior edge of the chisel is in front of the posterior margin of the greater trochanter, and the chisel is maintained horizontally, the sciatic nerve cannot be struck.* The nerve can be hit only if the chisel is directed posteriorly. In the course of many operations on the cadaver I have found that unless the chisel is directed at an angle of 45 degrees to 60 degrees backwards it is impossible to hit the nerve. There may perhaps be some danger when there is adduction deformity of the hip. In the flexed hip more care has to be exercised because the sciatic nerve may be on the stretch. It should be understood clearly that the area of bone at which one is aiming is not the tuber ischii but the bifurcation of the pelvic rami below the acetabulum, consisting of the anterior ramus of the pubis and the posterior ramus of the ischium. At this level the sciatic nerve is far behind, and it cannot be struck by a chisel which is placed horizontally.

Haemorrhage—Some oozing always takes place, and sometimes it may appear alarming. If the anterior pelvic brim is traversed, the obturator artery may be divided. In addition, one may divide branches of the lateral femoral circumflex artery taking part in the digital anastomosis, and there may be muscular oozing from dividing the iliopsoas and small muscle like the piriformis and obturators. None of this haemorrhage is serious, with the possible exception of that from the obturator artery in a debilitated patient. There is no doubt that oozing does take place and that it goes on after the operation, so that it is wise to have blood transfusions readily available. I have had no fatalities from haemorrhage, and shock is the exception rather than the rule. McMurray's statement that there is more shock after this operation than after any other method of arthrodesis is, in my experience, entirely without foundation. I would state dogmatically that if the operation is performed with correct technique there is much less shock than with any other method.

REASONS FOR FAILURE OF FUSION

The possible causes of failure are: 1) passing the chisel or graft through the obturator foramen, thus securing inadequate ischial contact; 2) non-union between the osteotomised femoral fragments, or between the graft and the femoral fragment at the outer end; 3) extension of disease into the area of the graft.

Passing the chisel or graft through the obturator foramen—Striking bone is, of course, of paramount importance, and it is wise to take the precaution of using a drill or guide as suggested by Freiberg (1946). I have adopted this measure during the past two years. In earlier observations I stated that the obliquity of the obturator foramen was such as to prohibit the passage of a graft through it, but this statement has had to be modified in the light of further experience. A graft directed transversely and horizontally may pass through the obturator foramen, especially in children where the tibia is not wide. Once again, a *wide* tibial graft is essential for this operation. If disease permits, the graft may be directed more vertically, when it is certain that bone will be struck. Extension of tuberculous disease may of course determine the position of the graft, but whenever possible the graft should approximate towards the vertical position.

Non-union between the osteotomised femoral fragments, or between the graft and the femoral fragment at the outer end—In three patients fibrous union occurred between the greater trochanter and the distal fragment of the femur. In two patients a second operation was performed, and union occurred after freshening these surfaces. This, of course, is a minor operation as compared with the major problem of securing fusion of the diseased hip. It is now my custom to fragment the outer surface of the greater trochanter and to place the bone chips in the site of osteotomy.

Extension of disease into the area of the graft—Extension of disease may be beyond the control of the surgeon. It seldom happens, but if it does the indication is for more prolonged immobilisation. Once there is no doubt that the graft has become diseased, the operation should be repeated. It is an important point that the second operation is less difficult than the first because the upper end, and the direction, of the first graft can be identified easily.

It must be emphasised that one of the essential features of the operation is that it is closed, and that its success may depend upon this. Wider exposures, which mobilise both femoral fragments in the attempt to see what one is doing, lose the advantage of fixation of the graft between the fragments and may cause non-union.

Results of Ischio-femoral Arthrodesis

Total number of operations	105
Total number of patients	95
Successful fusions	82

Tuberculosis of the hip—38 patients; 48 operations; 32 fusions.

Two patients required 4 operations; one, 3 operations; and two, 2 operations.

Osteoarthritis of the hip—52 patients; 45 fusions.

In seven cases the arthritis was secondary to congenital dislocation of the hip; one patient aged fifty-eight years died eight days after operation from pulmonary embolism confirmed by post-mortem examination.

Infective arthritis of the hip—5 patients; 5 fusions.

SUMMARY

It will be seen that the proportion of successful fusions in this series of ninety-five patients treated by ischio-femoral arthrodesis of the hip was over 80 per cent. Similar percentages of successful fusion have been reported by Knight (1945), Freiberg (1946), Langston (1947), and Nisbet, who was resident surgical officer at the Robert Jones and Agnes Hunt Orthopaedic Hospital, and informed me in a personal communication that he had carried out twenty-six operations with an approximate fusion rate of 80 per cent. He stated: "It is the only operation which gives a reasonable chance of a successful arthrodesis in children. Up till now at Oswestry the chances of a fusion by the other methods in children have proved so disappointing that the operation had been abandoned. Dame Agnes Hunt, with her vast experience of the condition, was always very annoyed when she found a surgeon trying to fuse a child's hip. All this has been changed."

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POSTERIOR DISLOCATION OF THE SHOULDER JOINT

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Dislocation of the shoulder joint with backward displacement of the humeral head is an unusual injury. The physical signs are often masked by swelling and, although careful study of antero-posterior radiographs may be suggestive, the diagnosis is often missed at the first attendance of the patient.

Wood (1941) reported three posterior dislocations in a series of 115 dislocations of the shoulder joint treated in the fracture clinics of the Massachusetts General Hospital between 1930 and 1938. Thomas (1937) reported four posterior dislocations in a series of 6000 shoulder examinations in his private practice, and he referred to three other cases. Wood found that the condition had received little attention in the text-books he studied; and such well-known books as those of Böhler (1935) and Watson-Jones (1943) include no separate description of this dislocation but simply mention the possibility of its occurrence. Many reported cases have been associated with fracture of the upper end of the humerus which may take the form of a compression fracture of the anterior aspect of the anatomical neck closely resembling the postero-lateral defect in the humeral head which may be observed in recurrent anterior dislocations.

It is significant that only four of the ten cases described by Wood and Thomas were recognised at the first attendance of the patient. Of the three cases reported in this paper, the first two passed unrecognised at the hospitals to which they were first referred. The third patient was examined by a well-trained and experienced surgeon who missed the clinical diagnosis and also failed to understand the X-ray films, but a recently qualified house-officer who could not understand why the coracoid process should be so prominent called the senior surgeon back for re-examination of the patient. After much discussion, the diagnosis was clinched when the head of the humerus was palpated behind the scapula. What is the explanation of this unsatisfactory state of affairs? What is the remedy?

Part of the explanation lies in the rarity of the injury which, being unsuspected, is not recognised when physical signs are so masked by swelling. Moreover, these cases are usually dealt with as emergencies by house surgeons who are provided with no more than a single radiograph taken in the antero-posterior plane—a projection in which they fail to recognise any abnormality. Such failure is quite understandable and the remedy is obvious. The same rule which is applied to the radiographic examination of long bones must apply to the shoulder joint; in all recent injuries there must be provided either a stereoscopic pair of radiographs, or radiographs taken in two different planes. For the radiologist, stereoscopic examination meets all requirements; but these films cannot be viewed by the surgeon until they are dry and moreover experience is required for their correct interpretation. Therefore in emergency work an alternative is necessary and the choice lies between: 1) transthoracic lateral projections; 2) vertical projections with the tube in the axilla or with a curved cassette in the axilla; and 3) profile projections in the postero-oblique axis with the patient erect.

Transthoracic lateral views display the upper part of the humerus satisfactorily but the shoulder joint is not well shown except in patients who are very slender and for this reason it is not a satisfactory projection. Vertical views with the tube in the axilla are often impracticable unless there is a free range of abduction movement of the shoulder joint, but, by reversing the positions of the tube and the film, and loading the film in a curved cassette, a satisfactory lateral view of the shoulder joint can usually be obtained (Fig. 1). If a vertical view with curved cassette is impossible the postero-oblique or profile view of the scapula

gives a satisfactory lateral projection of the shoulder joint in patients of average thickness—a projection which is interpreted readily by surgeons. These views are all standard radiographic positions and they are described and illustrated by K. C. Clark (1941).

CASE REPORTS

Case 1. E. S., female, aged 44 years—Injured in a brawl. Her doctor sent her to hospital with a diagnosis of dislocation of the left shoulder joint. Radiographic examination of the shoulder included only an antero-posterior view and this was believed to show no abnormality. Physiotherapy was ordered. After five weeks her doctor was still convinced of the accuracy of his original diagnosis and sent her to the Royal Victoria Infirmary, Newcastle, where the orthopaedic surgeon suspected a posterior dislocation. There was marked flattening of the anterior aspect of the shoulder and complete loss of humero-scapular movement. Radiographic examination included antero-posterior and vertical curved cassette projections.

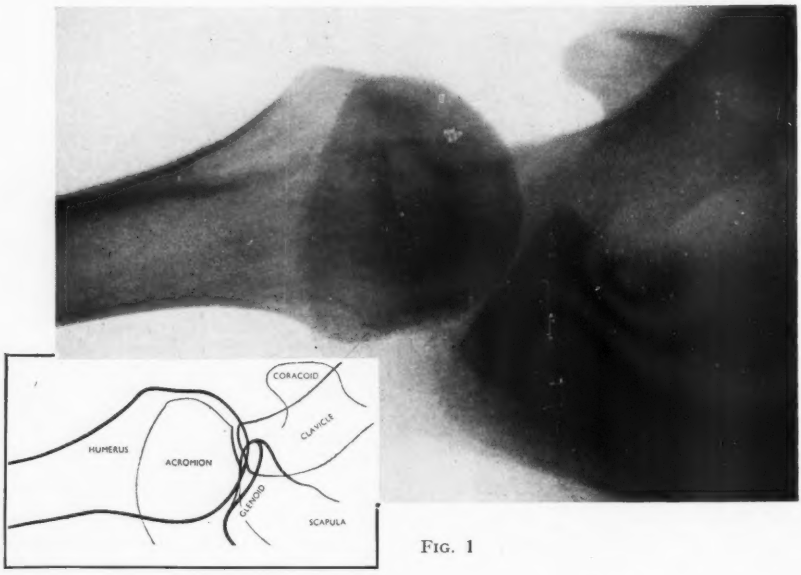

FIG. 1

Vertical projection of the normal shoulder joint with tube in the axilla and cassette above the shoulder.

The antero-posterior view showed internal rotation of the humerus, and elevation of the humeral head. The vertical film demonstrated posterior dislocation of the humeral head together with a compression fracture of the anterior aspect of the anatomical neck of the humerus with impaction of the posterior margin of the glenoid. Reduction was successful.

Case 2. A. H., male, aged 60 years—Injured by a fall of stone in a pit. He was sent to hospital with bruising of the left shoulder. A radiograph in the antero-posterior plane was considered to show no abnormality and the man was discharged home. Five weeks later his doctor sent him to the Orthopaedic Department of this Infirmary but the diagnosis was not suspected until further radiographs were examined. Stereoscopic views were taken. Reduction was attempted unsuccessfully. Five weeks later another antero-posterior film and a vertical projection with curved cassette were obtained; the first showed overlapping of the glenoid

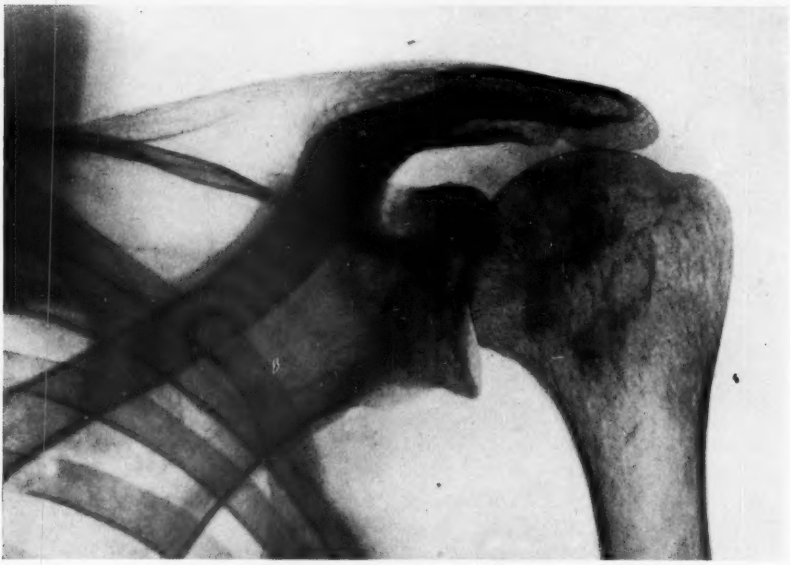

FIG. 2

Case 2. Antero-posterior radiograph shows slight overlap of the shadows of head of the humerus and glenoid, and elevation of the humeral head. From this view alone, surgeons might well have difficulty in establishing the diagnosis of posterior dislocation.

FIG. 3

Case 2. The vertical projection shows backward dislocation of the shoulder joint, with fracture of the posterior margin of the glenoid and a defect in the anterior margin of the humeral head from which a piece of bone has been detached.

FIG. 4

Case 3. Antero-posterior radiograph of the right shoulder which is dislocated posteriorly. In this projection the humerus is seen to be internally rotated.

FIG. 5

Case 3. Radiograph in vertical projection of the shoulder joint shows the posterior dislocation quite clearly.

by the humeral head and rotation of the scapula so that the whole length of the spine was visible (Fig. 2). In the vertical view, posterior dislocation of the humerus was evident and there was an associated fracture of the posterior margin of the glenoid; a defect was visible in the humeral head from which a piece of bone had been detached (Fig. 3).

Case 3. T. C., male, aged 43 years—Struck the front of his right shoulder against the back of a lorry while cycling, and was brought immediately to the Royal Victoria Infirmary, Newcastle-upon-Tyne. Examination showed that the right upper limb was held internally rotated and extended at the elbow. The outline of the shoulder appeared to be normal; but on palpation, the coracoid process was unusually prominent. No increase in the vertical circumference of the shoulder was shown by measurement. Ruler tests showed no flattening of the contour of the shoulder. The antero-posterior radiograph showed internal rotation of the humerus with the tuberosities overlapping the glenoid (Fig. 4). The vertical film, which was obtained in the almost complete absence of any abduction movement of the shoulder by lateral flexion of the spine towards the affected side and the use of a curved cassette, demonstrated the dislocation clearly (Fig. 5). A transthoracic view of the humerus was also taken and it showed the dislocation but much less satisfactorily than in the vertical view. Reduction was successfully achieved by traction upon the limb.

SUMMARY

Posterior dislocation of the shoulder is an unusual injury and there is often much delay before the diagnosis is made. Nevertheless, if the condition is borne in mind when examining the patient and studying the X-ray films the diagnosis should not be missed. A single antero-posterior radiograph of the shoulder joint is inadequate. For the radiologist a pair of stereoscopic films is desirable; but for routine emergency work in hospital other projections are necessary. A vertical view should be taken, either with the limb abducted and the tube in the axilla, or with the tube above the shoulder and a curved cassette in the axilla. When this is impossible a profile or posterior oblique view of the scapula may be substituted.

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Note.—The paper by Thomas reviews the literature from 1804 to 1937.

SQUAMOUS-CELLED CARCINOMA OF THE NAIL BED

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Squamous-celled epithelioma of the nail bed or sulcus is a well-known but uncommon type of neoplasm, examples of which have been recorded by Sigel (1937), Bunnell (1944), and Willis (1948). It is often mistaken for chronic paronychia. The insidious progress of the tumour, and the frequency with which it is wrongly diagnosed, make it of interest and importance.

The tumour must be distinguished from malignant melanoma of the nail. Both are found more often in the fingers than the toes, and the thumb is the digit most often affected, the right more so than the left. Some fifteen cases involving the hand have been recorded in

Fig. 1

Radiograph of both thumbs in Case 1. The terminal phalanx of the left thumb had already been amputated for what was believed to have been a whitlow. There is now almost complete destruction of the proximal phalanx.

the literature, mostly in men over the age of sixty years. There is often a history of trauma or infection which proved resistant to treatment.

Metastases in the phalanges of the hand from bronchial carcinoma, as described by Colson and Willcox (1948), must also be considered in the differential diagnosis.

CASE REPORTS

The three cases described here are sufficiently typical to make a general description of the history, progress, and pathology of these tumours unnecessary.

Case 1—A man, aged seventy-three years, had been treated by his doctor for a whitlow of the right thumb. The condition proved resistant to conservative treatment and radiographs

showed erosion of the terminal phalanx; disarticulation was therefore performed at the interphalangeal joint. The scar broke down and two or three minute sinuses discharged material which the patient likened to small quantities of tooth-paste.

Seven months after first coming under observation the sinuses were still present, but without signs of inflammation. The remaining part of the thumb was thickened; the overlying skin was red and there was slight tenderness. Radiographs (Fig. 1) showed almost complete destruction of the shaft of the proximal phalanx, leaving the base of the bone and a few flakes at the distal end.

The patient died of a perforated duodenal ulcer. Necropsy showed no evidence of visceral metastasis or of a primary tumour elsewhere. The axillary glands were not examined. Section of the thumb showed that the proximal phalanx was largely replaced by a white tumour (Fig. 2). Histological examination showed that it was a heavily keratinised squamous-celled epithelioma invading the bone (Fig. 3).

FIG. 2

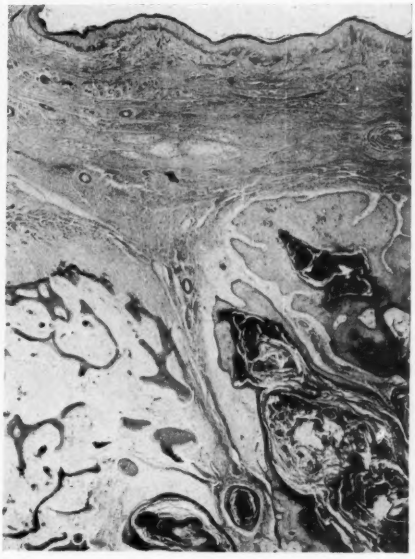

FIG. 3

Section of the thumb at post-mortem examination shows that the phalanx is replaced by a white tumour (Fig. 2). Microscopic examination shows a heavily keratinised squamous-celled carcinoma with prickle cells, invading the bone (Fig. 3—stained haematoxylin and eosin—× 10).

Case 2—A man, aged sixty-six years, had a whitlow of the thumb which resulted in loss of the nail. It was treated by fomentations. Three years later the thumb swelled and became painful. Amputation was performed.

The specimen showed a tumour 3 cm.× 1 cm.× 2·1 cm. at the tip of the thumb in the region of the nail which was missing. An ulcer with necrotic base and indurated thickened edges was visible in the nail bed. The cut surface presented a pink-white mass with haemorrhagic areas towards the centre. The terminal phalanx was completely destroyed.

Case 3—A woman, aged seventy years, had noticed swelling of the terminal phalanx of the right middle finger for three years. After one and a half years the skin broke down but radiographic examination showed no bone involvement. Amputation was performed.

The specimen presented a tumour 1·5 cm.×1 cm.×1·1 cm. lying under the nail and protruding distally. The skin over the tumour was pale, and close to the nail margin there was a small ulcer with thickened raised edges. The cut surface of the tumour was in parts white and necrotic, and it was invading the terminal phalanx. Histological section showed an atypical squamous-celled carcinoma invading bone.

Comment—The frequency of bone involvement in squamous-celled carcinoma of the nail bed is greater than previous descriptions would suggest. The liability to metastasis in the axillary glands makes their removal, as well as amputation of the digit, the treatment of choice.

My grateful thanks are due to Professor W. Newcomb and Dr R. Pugh of the Pathology Department at St Mary's Hospital for their help, and to Mr V. Z. Cope for permission to publish Case 3.

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HORIZONTAL APPROACH TO THE MEDIAL SEMILUNAR CARTILAGE

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During the recent war it became apparent that the results of removing a semilunar cartilage varied considerably both with regard to immediate freedom from effusion and ultimate function of the joint. In the first year, many end-results were unsatisfactory, but subsequently much more satisfactory results were obtained when better selection of cases before operation was enforced. Such selection, however, did nothing to elucidate the cause of some defective results which can follow meniscectomy: it evaded the question as to why results were variable; why there was so little relationship between success in the end-result and the amount of cartilage removed; and why the mere existence of ligamentous laxity appeared so seriously to prejudice the results of meniscectomy. In considering these problems, details of technique were keenly scrutinised in one hundred and fifty operations, particular attention being paid to: 1) size of the incision; 2) direction of the capsular incision; 3) double incisions with separate removal of the posterior horn; 4) division of the medial collateral ligament (Tavernier); 5) total meniscectomy as compared with removal of the displaced portion alone; 6) suture materials—catgut, thread, and no synovial suture; 7) haemostasis, using local anaesthesia without tourniquet; 8) post-operative dressings—pressure bandage alone, bandage with back splint, or bandage with plaster cylinder; 9) early or late ambulation and exercise.

It was sometimes evident that the size of the capsular incision was at least one factor accounting for post-operative trouble: it was noted that the smaller the incision the less was there likelihood of early or late effusion. Occasionally it was noticed that the scar became thickened, indurated, and of almost cartilaginous consistency. With the palpating finger resting on the scar an unpleasant click could be felt as the joint was extended actively from the flexed position. Those scars which were suspected as being a source of mechanical trouble were always vertical or oblique, and it seemed possible that the trouble might be due to movement of the scar from the articular to the non-articular surface of the femoral condyle. One such scar, which was markedly nodular, was removed. Beneath it was discovered a pannus extending on to the articular surface of the femoral condyle. In transit from the non-articular to the articular surface of the femur the scar produced a click on the bony ridge which separates these two surfaces. On its synovial surface the scar showed as an irregular white line, hard and gritty, and with histological evidence that there were no mucous cells on the synovial surface so that scar tissue was exposed in the joint cavity.

In view of these findings it was decided to use a horizontal incision at the level of the head of the tibia so that the scar could have no contact with the femoral articular surface (Fig. 1). This approach was condemned by Alwyn Smith (1928) for the reason that, in his view, it gave inadequate exposure and endangered the medial collateral ligament. Only brief reference was made to it by Abbott and Carpenter (1945) and Smillie (1946). In Manchester it has been used for many years by Sir Harry Platt.

OPERATIVE TECHNIQUE

A two-inch incision is made horizontally at the level of the head of the tibia from the medial border of the ligamentum patellae to the medial collateral ligament. The capsule is incised along the same line. The upper lip of the divided capsule is then dissected from the underlying synovial membrane and retracted upwards. The synovial membrane is opened along the upper border of the medial meniscus. The level of this incision is determined by first making a half-inch opening into the small synovial sac which lies below the meniscus, introducing a blunt hook, and passing it from below to the upper border of the meniscus.

By cutting down on to the point of the hook the definitive incision into the synovial cavity can thus be made at the lowest level. The anterior attachment of the meniscus is divided and vision into the joint, which till then has been restricted, becomes unobstructed. When the medial collateral ligament is retracted the low angle of vision into the joint by this approach is appreciated (Fig. 7). The rest of the meniscus is removed in the usual way. In closing the synovial membrane the suture should be started near the medial collateral ligament while the knee joint is still flexed (Fig. 9). Having started the suture at this point the joint must be extended to complete the suture. This is an important point because if the joint is extended before suture is begun the posterior part of the synovial incision becomes inaccessible under the medial collateral ligament. It will be observed that the suture line lies on the head of the tibia and cannot give rise to friction against the femoral condyles in any movement of the knee. Figs. 2–5 illustrate this and show how a horizontal suture obliterates the raw bed of the meniscus.

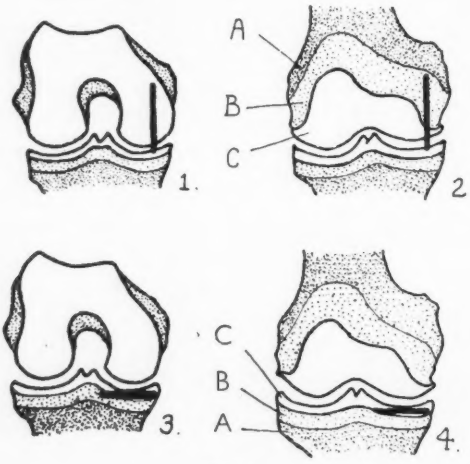

FIG. 1

Showing the relation of scars to the articular surface of the femur in flexed and extended positions of the joint. A vertical scar comes in contact with the non-articular, synovial-covered surface of the femur in extension; and there is a point of transition to the articular surface, marked by an oblique ridge, at which level the scar may produce a pannus spreading from the non-articular to the articular surface. The horizontal scar, if kept low on the tibial head, bears the same relationship to the femoral articular surface in flexion and extension (A—extracapsular; B—intracapsular; C—articular cartilage).

END-RESULTS

The total number of cases in which the medial meniscus was removed for undoubted lesions was one hundred and three. The results may be analysed thus:

	Cases	Per cent.
Perfect	35	34·0
Much better than before operation . .	43	42·0
A little better than before operation . .	15	14·5
The same as before operation . . .	2	1·9
Worse than before operation . . .	7	6·5
Much worse than before operation . .	1	0·9

Analysis based on the soldier's subjective view which did not always coincide with the surgeon's objective opinion. Thus the first two categories could not be distinguished from each other; nor was there physical explanation in the case of the patient who stated that his knee was "much worse."

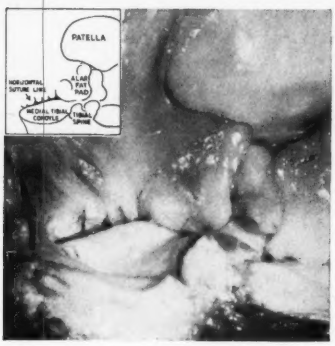

FIG. 2

The medial meniscus has been removed in the cadaver through a horizontal incision which has then been sutured. The synovial aspect of the suture line is viewed from the interior of the joint by removing the lower end of the femur after dividing the cruciate ligaments. The suture line has obliterated the raw bed from which the cartilage has been excised and lies remote from contact with the articular surface of the femoral condyles.

FIG. 3

The medial meniscus has been removed in the cadaver through a vertical incision which has then been sutured. The synovial aspect of the suture line is viewed from the interior of the joint by removing the lower end of the femur after dividing the cruciate ligaments. The raw bed from which the anterior half of the rim of the cartilage has been excised is visible, as well as the vertical suture line which lies in relation to the femoral condyles.

FIG. 4

Showing horizontal suture line concealed below the level of the head of the tibia—dissection opened out to reveal it.

FIG. 5

Showing horizontal suture line concealed below the head of the tibia—dissection closed up as in the normal joint.

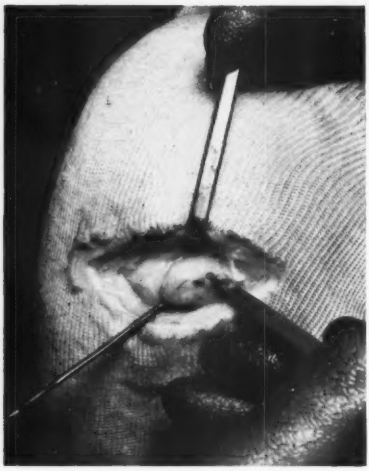

FIG. 6

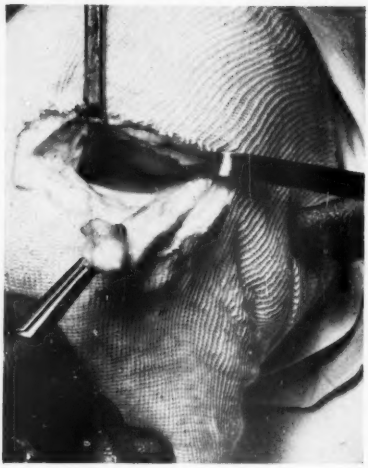

FIG. 7

The synovial cavity is opened for half an inch below the level of the meniscus by cutting down on the head of the tibia, and a blunt hook is passed under it and pulled out above to demarcate the upper level for the main horizontal incision (Fig. 6). After detaching the anterior horn a good view of the interior of the joint is secured with a low angle of vision (Fig. 7).

FIG. 8

FIG. 9

The rim of the meniscus is detached under direct vision with a tenotomy knife as used by Robert Jones (Fig. 8). The posterior horn is seen and divided. The first synovial suture is seen in Fig. 9; the joint is then extended and the edges of the synovia come together easily.

It was my impression that immediate recovery was quicker and less eventful after the horizontal incision than after meniscectomy through other incisions; but it will be seen that the late end-results were no better than the average of results published by other surgeons. Smillie (1946) reported completely successful results in 75 per cent. of cases, and incompletely successful results in 25 per cent. Du Toit and Enslin (1945) found a similar percentage of failures, and suggested that chondromalacia of the patella might be a frequent source of imperfection in the results.

In this series of one hundred and three cases no coincident lesions such as early arthritis, ulceration of articular cartilage, or ligamentous instability were discovered at operation in eighty cases; whereas such complications were recognised at operation in twenty-three cases. These two groups were analysed separately and yet no material difference was found in the percentage of successful results. The series was also divided into those cases in which removal of the meniscus was total and those in which it was sub-total, and again no material difference was found in the percentage of good and bad results. Indeed it appeared that the results of total removal were not quite as good as those of incomplete removal.

SUMMARY

1. It is suggested that slow recovery and post-operative effusion after meniscectomy may often be due to "scar friction" when the incision in the synovial membrane is in contact with the non-articular surface of the femoral condyle.

2. The advantages of a horizontal incision are discussed, particularly with regard to early recovery.

3. The results of one hundred and three cases of meniscectomy are analysed. An attempt to trace the cause of incompletely successful results in 25 per cent. of cases failed to show any relation to minor coincident lesions discovered at operation, or to the amount of meniscus removed.

I am indebted to Dr Ollerenshaw and Mr Kilshaw of the Department of Medical Photography for their co-operation in producing the illustrations.

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KNEE JOINT CHANGES AFTER MENISCECTOMY

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This paper records an investigation of changes found in the knee joint at intervals ranging from three months to fourteen years after meniscectomy. In a search of the literature only one reference to these changes has been found. Vandendorp, Bastien, and Vandecasteele (1939–40) observed in a few subjects that there was narrowing of the joint space and broadening of the femoral and tibial condyles on the operated side of the joint, but they offered no explanation of their findings.

RADIOLOGICAL STUDY

After excluding all cases with definite osteoarthritis, a comparison was made between the pre-operative and post-operative X-ray films in one hundred and seven cases of meniscectomy. Owing to difficulty in securing identical views on separate occasions, the changes to be described were accepted as convincing only because they were seen repeatedly; and occasionally a film of the normal knee joint provided better comparison. The changes noted, alone or in combination, were of three types: formation of an antero-posterior ridge projecting downwards from the margin of the femoral condyle over the old meniscus site (Figs. 1 and 2); generalised flattening of the marginal half of the femoral articular surface —a reaction similar to but more diffuse than the ridge (Figs. 3 and 4); narrowing of the joint space on the side of operation (Figs. 5 and 6) which, after lateral meniscectomy, was occasionally accompanied by apparent widening of the opposite side of the joint; in three patients this was sufficient to cause symptoms suggestive of mild valgus strain of the knee. The lateral views showed nothing of significance; nor was any change observed in the tibia apart from slight sharpening of the articular margin, insufficient to be described as osteoarthritis. It must be noted that the femoral ridge may be seen even before operation, particularly in cases with long-standing lesions of the meniscus, and sometimes in apparently normal joints. The changes have been seen within five months of operation on many occasions, but they tend to become more obvious with the passage of time. No correlation was found between clinical and radiographic findings, many knee joints with the most marked radiographic changes being functionally perfect. The frequency of such changes after medial and lateral meniscectomy was:

	Total cases	No change	Ridge	Narrowing	Flattening
Medial meniscectomy	80	33 per cent.	43 per cent.	32 per cent.	18 per cent.
Lateral meniscectomy	27	50 per cent.	7 per cent.	40 per cent.	17 per cent.

Narrowing plus flattening were the commonest changes found in combination.

INVESTIGATIONS

It is submitted that these changes result chiefly from loss of the weight-bearing function of the meniscus—a function which has not been accepted universally. Before enlarging on the problem two points must be emphasized. 1) If the normal meniscus is to take part in weight-bearing it can do so only if there is a force which prevents it from slipping away like an orange pip squeezed between the fingers. The peripheral attachments are loose and they are not designed to provide this counter-force, but there is another retaining mechanism which will be described later. 2) The elasticity of articular cartilage shows certain peculiarities (Hirsch 1944). Articular cartilage is perfectly elastic only for small loads applied for a very short time. If the load is maintained, deformation (*i.e.*, compression) continues slowly, and is not complete even after half an hour (Fig. 7). Recoil on removing the load has similar characteristics: the longer the load has been maintained the smaller is the immediate rebound

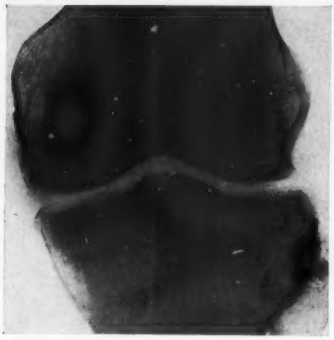

FIG. 1

FIG. 2

Patient, aged forty years, before operation (Fig. 1) and six years after removal of the medial meniscus, showing formation of a ridge from the margin of the femoral condyle (Fig. 2).

FIG. 3

FIG. 4

Patient, aged thirty-six years, before operation (Fig. 3) and seven years after removal of the medial meniscus, showing flattening of the femoral condyle (Fig. 4).

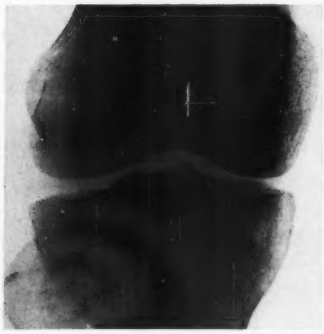

FIG. 5

FIG. 6

Patient, aged twenty-five years, before operation (Fig. 5) and five months after removal of the lateral meniscus, showing narrowing of the joint space laterally, and some widening medially (Fig. 6).

and the longer the gradual recovery phase; while if the load has been too great or too prolonged recovery is never complete. This is not the behaviour of a homogeneous substance. The structure of articular cartilage, with its fibrillar arcades (Benninghoff 1922, 1925), and the fact that local compression was seen to cause exudation of fluid from its surface, suggested that its elastic peculiarities might be comparable to those of a sponge. By using a simple modification of the elasticity apparatus designed by Bär (1926), strikingly similar curves were in fact produced from sponge rubber immersed in gylcerin (Fig. 8).

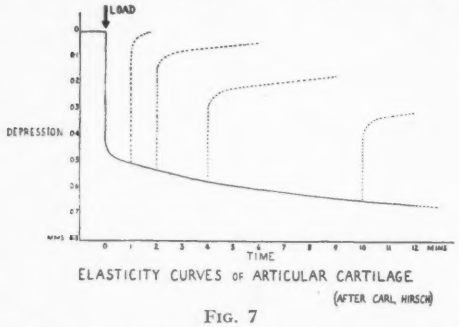

FIG. 7

The dotted lines represent recovery curves when the load is removed after increasing intervals.

With this behaviour in mind, and in order to observe the degree of compression which occurs in the living joint, radiographs were taken of normal knee joints in full extension and in the upright position. Very careful precautions were employed to obtain identical views for three exposures: 1) in the morning before any weight had been placed on the limb, the muscles gently bracing the knee joint into extension, and all weight being on the other limb; 2) with full weight on the knee after standing for a few minutes; 3) with full weight on the limb at the end of the day. In only one of seven subjects was the first view strictly comparable with the others be cause the degree of rotation and of extension both tend to alter slightly when weight is borne. By measuring the joint space in each view it was shown that the space narrowed by approximately one millimetre when weight was applied; and that by the end of the day it narrowed by another millimetre. Thus, as might be expected from the elasticity experiments, progressive compression of articular cartilage had occurred (Figs. 9 and 10).

A micrometric survey was then made of those parts of the femoral and tibial articular surfaces which are normally apposed in full extension, using an apparatus devised with the generous aid of Professor Thom, Professor of Engineering at Oxford (Fig. 11). By means of the lathe traversing, to which it was bolted, the gauge could be moved in the horizontal plane either sagittally or coronally for known distances. It recorded any vertical movement of the hemispherical pelotte, which rested on the articular surface and slid over it as the gauge was moved. The bone was firmly screwed to the base block. By taking gauge readings at each millimetre shift of the traversing gear it was possible to plot the curvature of a regular series of sections, sagittal and coronal, on a very large scale. These have been arranged to give perspective views of the apposed condyles (Figs. 12 to 15). Two knees were thus surveyed. Both were macroscopically normal and came from autopsy cadavers of women aged thirty and thirty-three years. The figures show how surprisingly incongruous are the joint surfaces, particularly in the sagittal plane, where much of the medial tibial condyle is almost flat and the lateral tibial condyle actually convex.

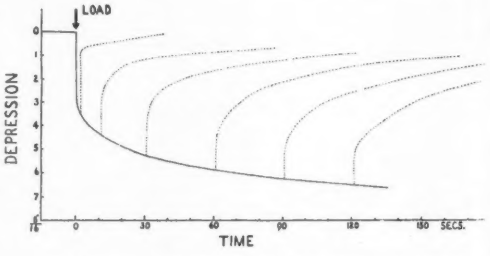

FIG. 8

Recovery curves of sponge rubber in glycerin for comparison with Fig. 7.

Fig. 16 represents diagrammatically a sagittal section through the lateral compartment of the knee joint. It is evident that until the articular cartilage has been compressed the femur

cannot bear upon the meniscus as a whole. Fig. 17 shows the effect of such compression. Tracings of apposed sagittal sections of the lateral femoral and tibial condyles were superimposed so that their intersections took place at a distance equal to that between the central margins of the meniscus, in this case twelve millimetres. The compression was therefore just sufficient to bring the femur down on to the meniscus. The articular cartilages were then sharing a central compression of one millimetre, which by the same method could be shown to be approximately the same in the medial compartment of the joint.

As compression increases, whether from sudden strains or in consequence of normal weight-bearing throughout the day, the circumference of the meniscus must be forced centrifugally. But in so far as the two ends of the meniscus are firmly attached to bone this force is resisted by rising tension in the stretched and elastic fibrocartilage. The greater the degree of joint

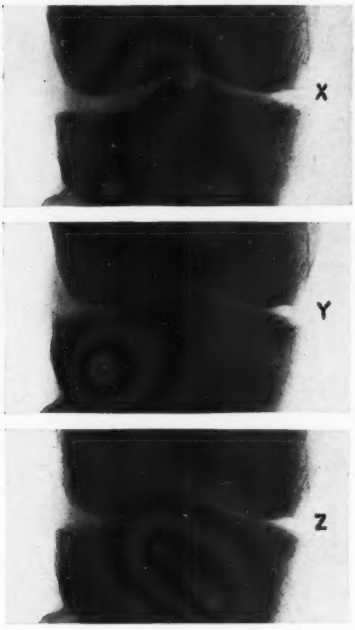

FIG. 9

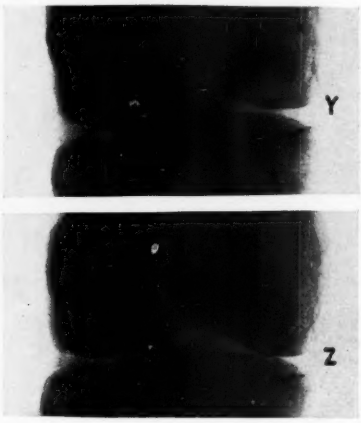

FIG. 10

Fig. 9 shows a normal knee joint after a night's rest without weight-bearing (X); after weight-bearing for two minutes (Y); and weight-bearing at the end of the day (Z).

Fig. 10 shows a normal knee, weight-bearing in the morning (Y) and in the evening (Z).

compression, the greater the circumferential tension in the meniscus. It is submitted that this tension resists extrusive forces and enables the meniscus to share in weight-bearing. That the tension is real was confirmed by stripping a knee joint of the outer soft tissues, while leaving the cruciate ligaments intact and the menisci in position but attached only by their central ends. In full extension the menisci remained slightly mobile until compression was applied, when the periphery of the menisci at once became hard and tense.

DISCUSSION

Meniscectomy must therefore result in relative overloading of the articular surfaces on that side of the joint, with increasing compression of the cartilage. But narrowing of the joint space after operation was seen in X-ray films of the recumbent patient, and if such narrowing is permanent, and radiographically demonstrable, it must be due either to structural

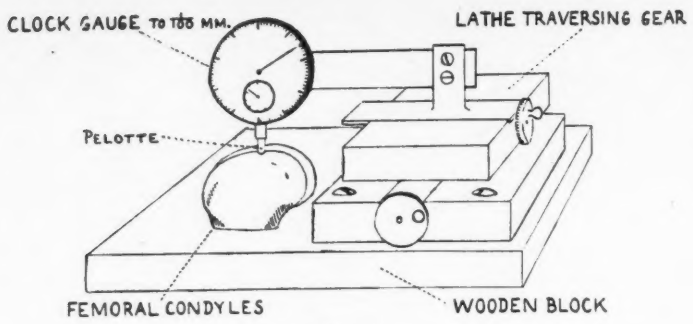

FIG. 11

Apparatus for articular survey (see text).

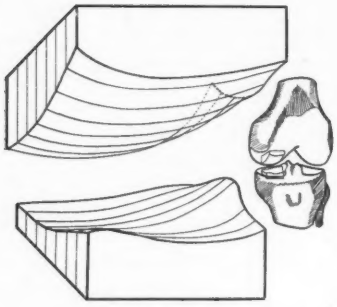

FIG. 12

Coronal section outlines of the medial condyles — interval between each section 3 mms.

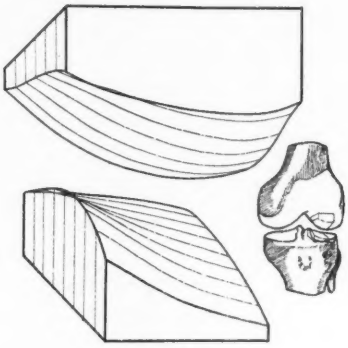

FIG. 13

Coronal section outlines of the lateral condyles—interval between each section 3 mms.

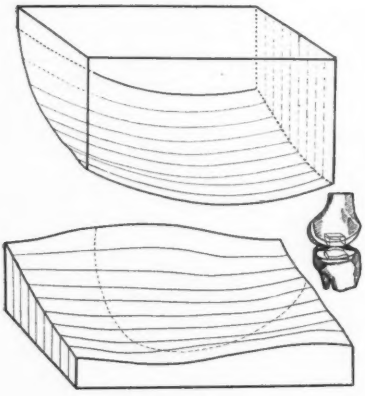

FIG. 14

Sagittal section outlines of the medial condyles—section intervals 2 mms. The dotted line on the tibial surface represents the central margin of the meniscus.

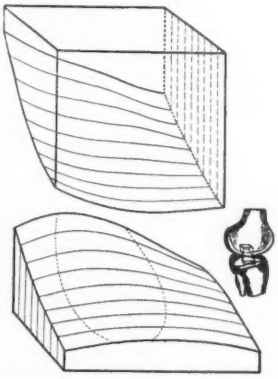

FIG. 15

Sagittal section outlines of the lateral condyles—section intervals 2 mms. The dotted line on the tibial surface represents the central margin of the meniscus.

changes in the articular cartilage which impair the power of recoil, or to actual loss of tissue. The method by which loss of articular cartilage from normal wear and tear is replaced, if it is replaced at all, is still in doubt. But the work of Elliott (1936) suggests that in the adult there is amitotic cell division occurring very close to the surface. The speed of this division is controlled by: 1) a nutritional factor which accounts for an increasing rate of cell division as the articular surface is approached; and 2) a mechanical factor, possibly associated with friction, which inhibits cell division and completely arrests it at the surface itself. Elliott's work was done on experimental animals and so far as can be ascertained it has not yet been confirmed in man, although this writer has made preliminary investigations. MacConaill (1932) stressed the importance of the meniscus as a lubricating mechanism and stated that loss of the meniscus caused a 20 per cent. increase in friction. It is reasonable to suppose that both nutritional and mechanical factors will be affected adversely when cartilage is overloaded, and the resulting interference with tissue replacement may account for the marked narrowing.

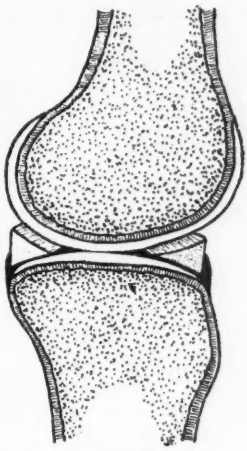

FIG. 16

Sagittal section to show that the femur cannot rest on the meniscus until compression of articular cartilage has occurred.

Flattening and ridge formation over the former site of the meniscus present another problem. These changes appear to be due to reaction in the overlying bone which is no longer subject to the pressure of the meniscus, although changes in the synovial blood supply at the margin may well be significant. We know that bone which is subjected to excessive pressure undergoes atrophy, and in the knee joint this may be seen in the lateral femoral condyle overlying a cystic meniscus. The condyle reacts in the opposite manner when normal pressure is removed; the mechanical effect is that of spreading the load of body weight.

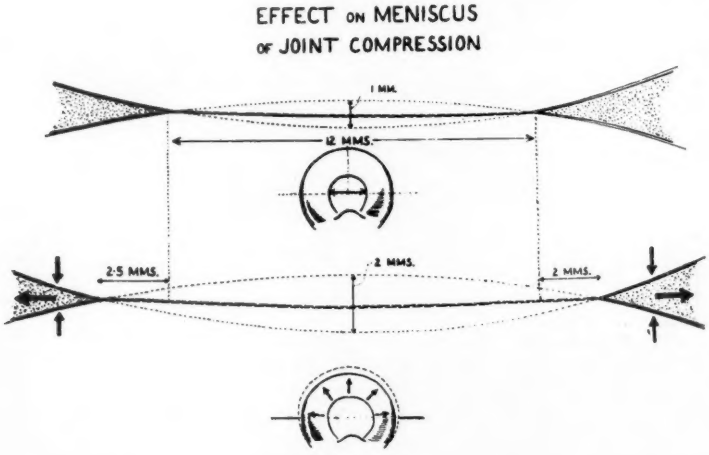

FIG. 17

Superimposed tracings of sagittal sections of the tibial and femoral condyles to show the effect of joint compression in producing centrifugal displacement of the meniscus (for explanation see text).

The final problem is why the findings should be inconstant. There appear to be two possible explanations: 1) variations in the reserve or safety factor of individual joints about

which we know so little; 2) variations in the speed and completeness of regeneration of the meniscus. In this series, the results of investigation by arthrography have been inconclusive; a knee with no changes whatever in the articular cartilage or bone was shown to have almost no replacement of the meniscus, while another with ridge formation had fibrous replacement of the meniscus almost to the normal size. Arthrograms also suggested that the ridge consists solely of bone and that the articular cartilage may still have an even and normally curved surface, because the thickness of the cartilage diminishes rapidly as the apex of the bone ridge is approached. It is worth remarking that in dogs, Bruce and Walmsley (1937) found that regeneration of an excised meniscus was still progressing and not yet complete even after five months, while Pfab (1927, 1928), Dieterich (1931), and King (1936) found evidence of degenerative changes in the overlying femoral condyle.

SUMMARY AND CONCLUSION

Changes in the knee joint after meniscectomy include ridge formation, narrowing of the joint space, and flattening of the femoral condyle. Investigations suggest that these changes are due to loss of the weight-bearing function of the meniscus. Meniscectomy is not wholly innocuous; it interferes, at least temporarily, with the mechanics of the joint. It seems likely that narrowing of the joint space will predispose to early degenerative changes, but a connection between these appearances and later osteoarthritis is not yet established and is too indefinite to justify clinical deductions.

My thanks are offered to Sir Harry Platt, the staff of the Wingfield-Morris Orthopaedic Hospital, and in particular to Professor H. J. Seddon for much helpful advice; to Mrs Crossley of the Photographic Department and Miss Robins of the X-ray Department for their patience and skill; and to Professor Thom and Mr Lund of the Oxford University Engineering Laboratory for generous help in micrometric joint surveys.

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THE CONGENITAL DISCOID MENISCUS

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Thirteen hundred meniscectomies, performed in the seven-year period 1941–48, included twenty-nine congenital discoid menisci. Each specimen was photographed, preserved, and annotated, together with relative clinical data. The material thus available for investigation, by comparison with any personal series hitherto described, presents a unique opportunity for the study of an interesting anomaly of development. In this article the anatomical and pathological features will be described, the lesions classified, and certain conclusions drawn. It is not proposed to discuss the comparative anatomy of the menisci or the development of the knee joint. That the menisci exist as cartilaginous discs at an early stage of development, and that the congenital discoid meniscus is due to occasional persistence of the foetal state, is not in question.

Classification—Study of the specimens suggests that three types of congenital abnormality may be recognised, each with distinctive features, and each susceptible to characteristic injuries corresponding to the anatomical type. The classification is of course arbitrary; the types represent no more than stages of arrest of a natural process of development, and infinite variations are possible. The two extremes, " gross abnormality " and " approaching normal," have been called—1) primitive, and 3) infantile; a type somewhere between is described as—2) intermediate.

THE PRIMITIVE DISC

If it is accepted that the shape of a normal meniscus is the result of gradual absorption during the latter half of foetal life of the central part of an originally complete plate, then it is reasonable to suggest that the more complete the disc, and the greater its breadth and thickness, the earlier the absorptive process must have ceased. The distinctive feature of the primitive disc is not so much its size, which varies within wide limits according to the age, sex, and build of the patient, but the lack of any suggestion that it was ever intended to be a meniscus (Fig. 1). The whole area where there is normally contact between the femur and tibia is filled in; so that, not only is there no point of direct contact between the bones but, the opposing articular surfaces are actively separated by fibrocartilage of a thickness which may be as great as 6 millimetres. The central free margin is thick; it is the shortest of all three types and it stretches almost directly between the anterior and posterior central attachments. The outline of the edge varies in form. It is often convex with a small notch at each extremity.

Measurement of the thickness of primitive discs—It has generally been assumed that the periphery of a congenital disc is thicker than that of the normal structure. In order to learn whether or not this assumption was correct, and if so, whether it applied to all three types, each specimen was measured at the deepest point in the middle segment. Of fifteen primitive discs, the thickest measured 9·75 millimetres, the thinnest 4·5 millimetres, and the average 7·6 millimetres. To compare these figures with the normal, thirty non-discoid lateral menisci, the subject of a variety of different tears, were taken at random; the depth of the periphery was measured at the same point. The thickest measured 10·5 millimetres, the thinnest 5·5 millimetres, and the average 7·5 millimetres.

In the primitive disc, unlike other varieties of disc and the normal meniscus, the depth of the free central margin is of measurable thickness. In the twelve specimens in which it

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was undamaged the greatest depth recorded was 6 millimetres, the least 2·5 millimetres, and the average 3·5 millimetres. It should be noted that these measurements were made on preserved specimens in which the degree of shrinkage during preservation is unknown, so that they must not be accepted as accurate measurements of menisci in the normal state. They are, however, comparable with each other, and it is clear that there is no less wide

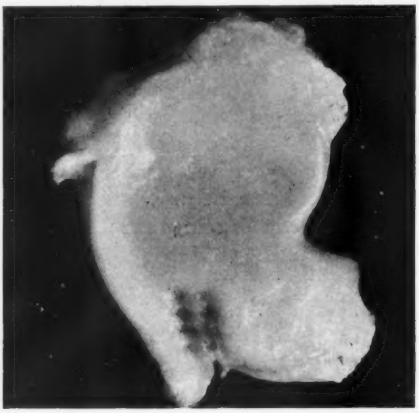

FIG. 1

FIG. 2

FIG. 3

Three types of congenital discoid meniscus.

The primitive type (Fig. 1) shows a complete disc without any suggestion that it was ever intended to be a meniscus; the central zone and the short free central margin are thick. *The intermediate type* (Fig. 2) is less massive and less complete; it is thinner, to the point of transparency in the central zone. *The infantile type* (Fig. 3) approaches the normal, differing in the greatly increased breadth of the middle segment.

variation in the depth of the peripheral rim of primitive discs than in normal lateral menisci. Primitive discs do, of course, occur with a periphery which is thicker than the normal, but the average thickness of a number of specimens is no greater than that of a similar number of normal lateral menisci. The comparative increase of thickness of primitive discs applies to the central unabsorbed portion, and especially to the free margin, but not to the periphery.

Injuries of the primitive disc—As might be expected, injuries of congenital discs are more extensive and more unusual in the thick and complete primitive types than in those which more closely resemble the normal structure. The thick central part of these discs, being interposed between the femoral and tibial condyles, is subject to direct compression, as well as to the antero-posterior and rotatory strains to which the normal meniscus is subject. The lesions correspond to the strains imposed, namely: 1) horizontal cleavage, resulting directly from the thickness and completeness of the disc; and 2) longitudinal and transverse tears such as may be sustained by any lateral meniscus.

Horizontal cleavage—Splitting of the fibrocartilage in its transverse or narrow axis may occur in the normally shaped adult meniscus in several ways, for example: when the centrally displaced part of a longitudinal tear rotates in its long axis and is trapped between the condyles; or when two opposing edges of a tear impinge on one another, as in the incomplete transverse tear of the lateral meniscus which has been described elsewhere (Smillie 1946); or in a joint in which the accessory supporting structures are so lax that the meniscus can rotate in its long axis. None of these mechanisms can apply in the case of congenital discs. The horizontal split is due to continuous movement of the superior on the inferior surfaces. While the superior surface claims the normal accessory relationship to the moving femoral condyle, the inferior surface is fixed, relatively firmly, to the tibial head (Fig. 4a). Continuous flexion and extension movement, aided by rotatory movement, lead to a horizontal line of cleavage between the two surfaces (Fig. 4b). That this explanation is correct is proved by specimens in which there is a space between the superior and inferior surfaces, extending throughout a large part of the total area of the structure, and yet in which external examination reveals no sign of injury in either surface. The appearance is that of an empty cystic space within the substance of the fibrocartilage (Fig. 5). This is the earliest manifestation of a lesion which, with the passage of time, becomes greatly modified by further wear and tear.

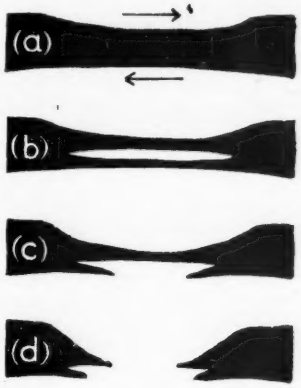

FIG. 4

Diagrammatic representation of the stages of horizontal cleavage: a) the superior and inferior surfaces shift in relation to one another; b) a line of cleavage appears; c) the inferior surface wears away; d) wearing of both surfaces causes a central hole.

Longitudinal tears—Transverse tears of a primitive disc, complete or incomplete, are impossible; there is no concave margin to be stretched and torn. Longitudinal tears, however, are common. They are located usually on the inferior surface, closer to the central than to the peripheral margin. In none of the longitudinal tears of primitive discs were both surfaces divided. In this respect they differ from the longitudinal tears of ordinary menisci, and from those of the intermediate type to be described later. The penetration of one surface does, of course, produce an outside entrance to the plane of horizontal cleavage (Figs. 6 and 14).

Attenuation of the inferior surface of the disc—Continuation of the stresses which cause horizontal cleavage gives rise to gradual destruction of the fibrocartilage until a time is reached when the inferior surface is so attenuated that it is worn away (Fig. 4c). The under-surface of such a specimen shows the original horizontal split clearly defined at the margins of the crater which has been produced (Fig. 7A). At this stage, contact between the condyles is prevented only by the thin superior surface of the disc. Judging by the number of specimens which show this particular feature, the thin membrane of this superior surface appears to be resistent to further destruction for some considerable time.

Central hole in the disc—In the last stage both inferior and superior surfaces are so worn

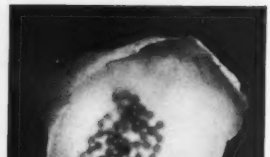

FIG. 5

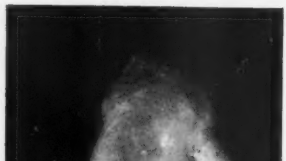

FIG. 6

FIG. 7A

FIG. 7B

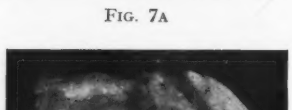

FIG. 8A

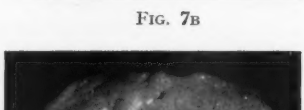

FIG. 8B

Horizontal cleavage in the primitive disc.

In the specimen shown in Fig. 5 both surfaces are intact but a line of cleavage has appeared within the substance of the fibrocartilage; it is outlined by lead shot introduced through a slit cut in the periphery (photograph with transmitted light). Fig. 6 shows a specimen in which a short longitudinal tear has occurred on the superior surface, entering the line of cleavage. The specimen in Fig. 7A shows wearing of the inferior surface permitting the femoral condyle to sink into the meniscus; the superior surface of the same meniscus shows the facet produced by the condyle (Fig. 7B). The specimen in Fig. 8 shows wearing of both surfaces producing a central hole; the inferior surface shows the original line of cleavage at the margins of the hole (Fig. 8A).

away that there is a hole in the centre of the specimen (Fig. 4d). The original line of cleavage can still be seen at the margins of the hole (Fig. 8A).

Summary of the four types of injury of primitive discs—The various stages of the lesion, and the frequency of each stage in this series, may be summarised thus: 1) a plane of cleavage appears in the substance of the fibrocartilage between the undamaged superior and inferior surfaces (two cases); 2) longitudinal tears are superimposed, usually on the inferior aspect (four cases); 3) the inferior surface is worn away and a shallow crater is produced (six cases); 4) both inferior and superior surfaces are worn away, thus producing a hole in the centre of the disc (two cases).

Ridges on the surface of a primitive disc—Other writers have drawn attention to the presence of a ridge on the superior surface of certain specimens and have discussed the relationship of this ridge to the "snapping knee." This ridge, or wave, is said to have arisen in consequence of weight-bearing but no precise information has been offered as to the mode of origin. Ridges of sufficient degree to account for "snapping knee" were noted in two specimens in this series. The position varies. When there is a single ridge, it runs obliquely forwards and outwards from the free central margin to the periphery, and it marks the division between a posterior facet where the femoral condyle lies in flexion, and an anterior facet where the condyle lies in extension. When only one recognisable facet is present, two ridges may exist, one in front and one behind the point occupied by the femur. The question arises as to whether this ridge is elevated above the natural level of the original structure, heaped up by the action of weight-bearing as has been hinted in previous descriptions, or whether there is some more simple explanation. Measurements of the ridge, both at the periphery and at the central margin, show that it is no higher than the original structure. The explanation is afforded by the pathological changes in primitive discs already described. These ridges are due to wearing of the inferior surface which allows the superior surface to sink, so that eventually a smooth hollow is produced for reception of the femoral condyle (Fig. 7A). The ridges are no more than intact strips of fibrocartilage. Moreover, and in further evidence that this explanation is correct, they do not necessarily run transversely in the short axis of the disc. Two parallel ridges of comparable height may sometimes be seen in the long axis of a thick specimen. The significance is the same; they simply outline the medial and lateral borders of a depression produced by the femoral condyle.

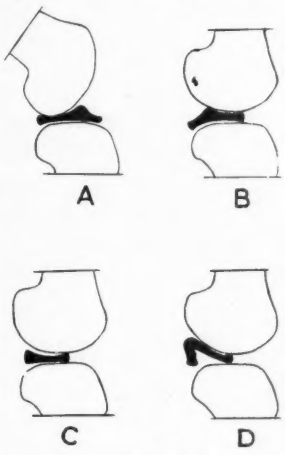

FIG. 9

The cause of "snapping knee"—A) relation of femoral condyle to the ridge in flexion; B) relation of femoral condyle in extension; C) the condyle has slipped over the anterior margin of a small disc lying horizontally in the posterior compartment; D) the condyle has slipped over the anterior margin of a large disc, flexed upon itself in the posterior compartment.

Cause of the "snapping knee"—In this series there were only four cases in which a congenital discoid meniscus was associated with the dramatic sign of "snapping knee" (see Table I). The writer has also had the opportunity of examining three other cases, two described by Middleton (1936), and one seen before 1940 and not included in this series. The snap occurs as the result of sudden alteration in the usual relationship between the meniscus and the femoral and tibial condyles, the actual sound being produced by backward or forward movement of the meniscus at the moment that the femoral condyle rides over: 1) the thick intact strip of fibrocartilage which forms the anterior boundary of the facet produced by the femoral condyle; or 2) the thick anterior peripheral margin of the meniscus itself.

It is evident that no alteration in the accustomed relationship between the meniscus and the opposing condyles can occur until antero-posterior mobility of the meniscus is increased much above the normal. The deeper the femur sinks into the substance of the fibrocartilage, the closer the meniscus must follow movements of the condyle, and the greater must be the subsequent stretching of both anterior and posterior peripheral attachments. Eventually, perhaps because of some trivial incident which occurs when the knee joint is in a position just short of full extension, the condyle mounts the ridge, or slips over the anterior periphery, and drives the meniscus backwards. This action completes the stretching, or even tears the anterior peripheral attachment so that the meniscus comes to lie partly, or completely, behind the femur (Figs. 9B, 9C, and 9D). Return to the original position takes place at a point short of full flexion when the condyle mounts the ridge from the opposite side and drives the structure forward again.

In two cases in this series the snap was due to a ridge (Figs. 9A and 9B). At operation the peripheral attachment was found to be stretched. When it had been divided, the margin of the meniscus was seen appearing just beneath the femoral condyle. Traction on the periphery, or further flexion of the joint, made the meniscus slip forwards so that the femoral condyle lay in the large posterior facet.

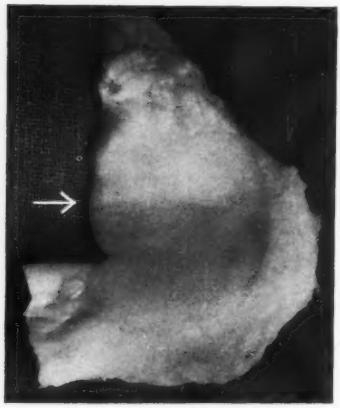

FIG. 10

Inferior surface of a primitive disc which lay flexed acutely upon itself behind the femoral condyle in extension; the anterior peripheral attachment was completely torn. Note the groove corresponding to the apex of the curve.

In the other two cases a snap was produced by the condyle slipping over the thick anterior margin so that the meniscus lay behind the femoral condyle. In one, the peripheral attachment took the form of a transparent film of tissue stretched over the articular surface of the tibial table; the meniscus was small enough to lie horizontally behind the condyle (Fig. 9C). In the second, the peripheral attachment was completely torn; in this case the disc was so large that it could not be accommodated except when flexed acutely upon itself behind the femur (Fig. 9D). The specimen showed a deep furrow which corresponded to the apex of the curve (Fig. 10).

Other sequelae of horizontal cleavage—Three primitive discs, each with horizontal cleavage, were discovered in the course of other operations—two during routine examination of a joint after removing a torn medial meniscus, and one in the course of an operation for osteochondritis dissecans involving the medial femoral condyle. Could there be any association between these conditions? In two cases of injury of the medial meniscus the lesion was not the usual longitudinal tear; it was an injury of the type which is associated with recurrent incidents in an unstable joint. In the third case, osteochondritis of the medial femoral condyle was due to impingement of the tibial spine. It is not unlikely that all three lesions were the direct result of instability due to horizontal cleavage in a thick, weight-bearing, lateral meniscus.

THE INTERMEDIATE DISC

It is difficult to define the intermediate type of congenital discoid meniscus. The title suggests that it lies midway between the primitive and infantile types of disc, but undoubtedly it resembles the primitive type more closely, so much so that it might be regarded as a subtype rather than a separate variety. The principal difference is that it is less massive, less complete, and much thinner in the central zone (Fig. 2). The central margin shows two

TABLE I

No.	Sex	Age	Side	Anatomical type	Outstanding features of the lesion	Cystic degeneration
1	M	18	R	Primitive	Horizontal cleavage: superficial longitudinal tear of the inferior surface	Yes
2	M	33	L	Primitive	Horizontal cleavage: surfaces undamaged	—
3	M	21	L	Intermediate	No obvious lesion	—
4	M	31	L	Primitive	No obvious lesion	—
5	M	25	R	Infantile	Posterior peripheral longitudinal tear	Yes
6	M	27	L	Primitive	Horizontal cleavage: inferior and superior superficial tears resulting in a hole in the centre	—
7	M	33	R	Infantile	Incomplete oblique tear	Yes
8	M	20	L	Primitive	Horizontal cleavage: anterior peripheral detachment	Yes
9	M	29	R	Primitive	Medial cartilage. Horizontal cleavage: whole inferior surface worn away	Yes
10	M	20	L	Primitive	Horizontal cleavage: anterior and posterior ridges resulting from wearing away of inferior surface: posterior peripheral detachment	—
11	M	21	L	Intermediate	Anterior longitudinal tear	—
12	M	30	R	Primitive	Horizontal cleavage: both surfaces worn away resulting in a hole in the centre	—
13	M	25	R	Primitive	Horizontal cleavage: anterior peripheral longitudinal tear	—
14	M	22	L	Infantile	Incomplete oblique tear	Yes
15	F	25	L	Primitive	Horizontal cleavage: single ridge resulting from wearing away of the inferior surface	—
16	M	51	L	Infantile	Incomplete oblique tear	—
17	M	18	R	Primitive	Horizontal cleavage: under-surface worn away	—
18	M	36	L	Intermediate	Posterior longitudinal tear	—
19	M	17	L	Infantile	Structure undamaged: torn from all peripheral attachments in the course of dislocation of knee	—
20	M	14	L	Primitive	Horizontal cleavage: superficial longitudinal tear of the inferior surface	—
21	M	51	L	Primitive	Horizontal cleavage: inferior surface worn away	Yes
22	M	17	R	Intermediate	Posterior longitudinal tear	—
23	F	20	R	Intermediate	Anterior peripheral detachment	—
24	M	26	L	Intermediate	Posterior peripheral detachment and posterior longitudinal tear	—
25	M	26	R	Primitive	Horizontal cleavage: superficial longitudinal tear of the superior surface	Yes
26	M	19	L	Infantile	Incomplete oblique tear	Yes
27	F	15	R	Primitive	Horizontal cleavage: anterior portion inferior surface worn away: gross stretching anterior peripheral attachment	—
28	M	16	R	Intermediate	Structure undamaged: gross stretching of the posterior peripheral attachment	—
29	M	16	L	Intermediate	Posterior peripheral detachment and posterior longitudinal tear	—

In Cases 10, 15, 23, and 27 there was the dramatic sign of "snapping knee" which made pre-operative diagnosis easy. The correct diagnosis was also made before operation in Case 29 (which was the second knee in a bilateral case) and in Case 26 where success was attributable to no more than "intelligent anticipation."

notches, one behind the anterior central attachment and one in front of the posterior central attachment. Between the notches is a convex area directed towards the centre of the joint. But the characteristic of this type is not so much the outline of the free border, which may be seen also in the primitive variety, as the thinness of the border, even to the point of transparency, a feature which is present, if in lesser degree, throughout the whole central region. This in fact is the type, and the only type, to which the vague words so often used, "thin and transparent on the medial border," actually apply. The depth of the periphery of eight such specimens varied between 5 and 6 millimetres. The rim was thus less deep than the normal average.

Injuries of the intermediate disc—The characteristic injury sustained by congenital discs of the intermediate type is a peripheral or extra-peripheral longitudinal tear. Five specimens showed posterior lesions. In four it took the form of a longitudinal tear. Two of these also showed posterior peripheral detachment (Fig. 11). In the fifth case

FIG. 11

FIG. 12

Intermediate discs showing posterior longitudinal tears.

Fig. 11 shows a specimen with posterior peripheral detachment and posterior peripheral longitudinal tear. Fig. 12 shows a longitudinal tear entering at the posterior notch.

the posterior peripheral attachment was markedly stretched. Two showed anterior lesions, one taking the form of a longitudinal tear, and one a complete detachment of the anterior segment. In one case there was no obvious injury. In no specimen was there evidence of a compression lesion of the central zone such as was seen in the primitive disc. It appears, therefore, that injuries sustained by congenital discs of the intermediate type correspond more or less exactly to the usual injuries of normal lateral menisci. The intrusion of a thin central zone between the femoral and tibial condyles does not appear to exert any influence on the type of injury sustained.

THE INFANTILE DISC

In some respects this type resembles the meniscus as it exists in the full-term foetus. It is the variety of congenital abnormality which most nearly approaches the normal structure, differing only in the very greatly increased breadth of the middle segment. One of the characteristic features of the normal lateral meniscus is the uniformity of breadth of the anterior, middle, and posterior segments. Nevertheless, there is often increase in the width of the middle segment which is considered to lie within the bounds of normality. Only cases in which this increase was unmistakably abnormal have been included in this group (Fig. 3).

There were six such cases. The depth of the periphery varied between 9·5 millimetres and 6 millimetres; the average was 8 millimetres. The periphery was thus slightly thicker than the normal average. The fibrocartilage tapers to a sharp crescentic edge, as in the normal structure.

Injuries of the infantile disc—The normal lateral meniscus is subject not only to the usual peripheral and extra-peripheral longitudinal tears, but also to an intrinsic lesion, namely, incomplete transverse or oblique tear (Smillie **1946**). This particular injury occurs on the lateral side for the reason not only that the meniscus is more broad but also that it is a segment of a smaller circle than its medial counterpart. Thus any force which tends to straighten the concave margin is likely to cause a transverse tear. It is to be expected that liability to such a tear would be greater in the infantile type of disc, because the concave edge is even less in a position to withstand strains which tend to increase the distance between the anterior and posterior segments. Four of the six specimens demonstrated this lesion (Fig. 13). There

FIG. 13

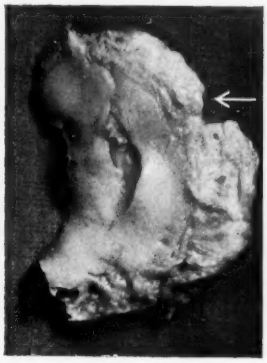

FIG. 14

Infantile and Primitive discs with tears.

Fig. 13 shows an infantile disc with an incomplete oblique tear. Fig. 14 shows a primitive disc with surface split entering horizontal cleavage, and multiple cysts in the peripheral zone.

was one which showed a posterior peripheral longitudinal tear, and one in which the meniscus had been torn from its posterior peripheral attachment.

Two anatomical types of normal lateral meniscus—It has already been stated that thirty ordinary lateral menisci were taken from the general collection for the purpose of comparing the depth of the periphery with that of the normal structure. In the course of taking measurements it became obvious that there were, in general, two anatomical types—one in which the anterior, middle, and posterior segments were of uniform breadth and where the lesion was either a longitudinal tear or a peripheral detachment of the posterior segment; and one in which the middle segment was much more broad and in which the lesion was almost invariably an incomplete transverse tear. Comparison between these menisci, and the six discs to which the name " infantile " has been attached, make it clear that they were no more than outstanding examples of a common type which by reason of abnormality of breadth is liable to a particular injury. It is thus evident that the six cases now recorded as congenital discs of the infantile type do not represent a true picture of the frequency with which this variety occurs. Nor is it unlikely that, as a source of trouble in the knee joint, further experience may prove it to be the most important of the three anatomical varieties.

COMPARISON OF ANATOMY AND PATHOLOGY WITH PREVIOUSLY REPORTED CASES

From the descriptions and illustrations which have been published in earlier articles, it is clear that many specimens on record correspond closely to the primitive and intermediate types here described. It is evident also that the infantile type of disc has been recognised as a congenital abnormality: for example, Bell Jones (1935) illustrated a typical specimen showing the characteristic incomplete oblique tear.

The curious varieties which have been described in some earlier papers have not been seen. There has been no case of anterior and posterior horns joined by fibrous tissue as recorded by Naughton Dunn (1934); or of reversed disc, absent posterior half, or free margins in unusual positions, as recorded by Fairbank * (1937). It is difficult to explain such entities on embryological grounds. Some may be freaks; but it seems probable that most of them were extraordinary examples of the effects of injury on primitive discs. For example, the " reversed disc " and those with a " hole in the centre," described by Fairbank (1937) and McMurray (1942), almost certainly represent the late stages of horizontal cleavage. The " absent posterior half," and " free margins in unusual positions," are examples of peripheral detachments known to be common in the congenital abnormality.

ASSOCIATION OF CONGENITAL DISCS WITH CYSTIC DEGENERATION

The association of cystic change with congenital malformation has been recorded by Ollerenshaw (1935), Herzmark (1936), Ober (1939), Meekison (1940), Kulowski (1940), and Kulowski and Rickett (1947). In this series nine specimens were the subject of cystic degeneration, this being the diagnosis which led to operative intervention. Cystic changes occurred in five primitive discs (Fig. 14), including the one example of medial disc (Figs. 15, 16A, 16B,) and in four infantile discs. This is not the occasion to discuss the etiology of meniscus cysts. The writer holds the view that they are traumatic in origin. If it is correct to believe that congenitally abnormal menisci are even more vulnerable to injury than normal menisci, it might reasonably be expected that the incidence of cystic degeneration would also be higher. The statistics of this series of cases cannot establish proof, but they suggest that this may be true. In a total of 468 lateral meniscectomies, 105 showed cystic degeneration—namely 22 per cent. In twenty-eight lateral discs, eight showed cystic degeneration—28 per cent.

DISCOID MEDIAL MENISCUS

Until 1945, when Dwyer and Taylor's case was described, there appears to be no record in the literature of a discoid medial meniscus. It was accepted that the anomaly occurred only on the lateral side of the joint. The only case which the writer has seen was operated upon in 1943 and reported in 1946. This specimen, and the one described by Dwyer and Taylor, were both discs of the primitive type. It is thus evident that congenital malformations of the discoid type may occur in either meniscus, but that persistence of the embryonic state on the medial side is very rare.

Injuries of the discoid medial meniscus—The single specimen available for examination had originally been the subject of horizontal cleavage but almost the entire inferior surface had worn away, leaving evidence of the primary lesion only at the anterior half of the periphery (Fig. 16B); the superior surface was undamaged (Fig. 16A). In addition to the

* By courtesy of Sir Thomas Fairbank, the writer has been permitted to examine the clinical notes and original drawings of his fifteen cases, three of which were bilateral.

lesion of the substance of the fibrocartilage, there was cystic degeneration; and this was the diagnosis with which the patient came to operation (Fig. 15). Unfortunately the exceptional nature of the case was not appreciated at the beginning of the operation and no care was

FIG. 15

Clinical appearance of the knee in a case of discoid medial meniscus with cystic degeneration.

FIG. 16A

FIG. 16B

Disc removed from the knee joint shown in Fig. 15. Fig. 16A shows the undamaged superior surface. Fig. 16B shows the inferior surface; it is worn away; the original horizontal cleavage is seen at the periphery. (The cyst has been removed from the specimen.)

taken to preserve the attachment of the cystic mass to the meniscus; it was located at the junction of the anterior and middle thirds of the periphery. In the case reported by Dwyer and Taylor (1945) the photograph and accompanying description indicate that there was horizontal cleavage of the disc with also a longitudinal tear on the superior surface.

SUMMARY

1. A personal series of twenty-nine discoid menisci is reviewed.
2. Three anatomical types are recognised and described.
3. The characteristic lesions incurred by each type is recorded.
4. The anatomical and pathological features of the specimens are compared with those of cases previously recorded.
5. A discoid medial meniscus is described, and compared with the only other specimen known to be recorded in the literature.

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SOME ANATOMICAL DETAILS OF THE KNEE JOINT

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In current texts, descriptions of the knee joint lack precision in certain details, and it is believed that revision of the anatomy of this important joint might be of value. It is proposed to give an account of the true capsule of the joint, the accessory ligaments, and the attachment of certain muscles.

CAPSULE AND ACCESSORY LIGAMENTS

In order to appreciate the arrangement of the capsule and ligaments of the knee joint it is advisable to consider the joint in the foetus, and trace the changes which occur during development of the adult structure. In the foetus the joint is a simple diarthrodial structure, the capsule being attached around the articular surfaces including that of the patella. The upper end of the fibula articulates with the femur; and the conjoined horizontal surfaces of the tibial plateau and upper end of the fibula are surrounded by a simple tubular capsule which is attached at its upper circumference round the articular surface of the femur. The capsule is interrupted anteriorly by a gap, to the margins of which the articular surface of the patella is attached. At this stage the joint already contains the two menisci.

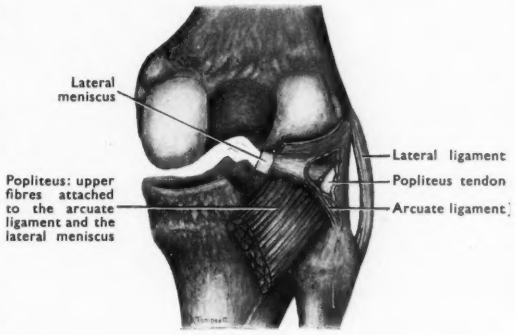
Lateral meniscus
Lateral ligament
Popliteus tendon
Arcuate ligament
Popliteus: upper fibres attached to the arcuate ligament and the lateral meniscus

FIG. 1

The popliteus . . . attached to the lateral meniscus.

Lateral ligament of the knee joint—As a result of the different rate of growth of tibia and fibula, the fibula is excluded from the knee joint; its upper end sinks below the tibial plateau and articulates with the tibia at the superior tibio-fibular synovial joint. The head and styloid process of the fibula pull down with them a prolongation of the original capsule. The margin of the tibia from which capsule is lacking (having been " stolen " from it by the fibula) is that part over which the tendon of popliteus passes. This part of the capsule is the short external lateral ligament of old terminology; in current British terminology it has no name. It might be described as the deep part of the lateral ligament of the knee joint. It represents part of the true joint capsule. It is attached above to the lateral epicondyle of the femur and below to the styloid process and medial (tibial) border of the upper surface of the head of the fibula. Its free posterior border, lying over the popliteus fascia and firmly adherent thereto, constitutes the arcuate ligament (Fig. 1). The arcuate ligament is attached firmly towards its upper end to the posterior arch of the lateral meniscus. Morphologically, the long external lateral ligament of old terminology (or the lateral ligament of the knee joint of current terminology) may be the degenerated tendon of peroneus longus (Bland Sutton 1884, Wheeler Haines 1941). It arises from the lateral epicondyle of the femur, in continuity with the upper part of the short external lateral ligament already described. It is inserted into the upper surface of the head of the fibula, lateral to the deep part (Fig. 1). Between them the deep part of the tendon of biceps femoris is inserted, thus separating them at the head of the fibula. The long external lateral ligament (lateral ligament of current terminology) divides the tendon of biceps into superficial and deep parts.

Medial ligament of the knee joint—Like the lateral ligament, the medial ligament possibly consists of two, morphologically distinct, parts. The deep part, named in old terminology the short internal lateral ligament, has no name in current British terminology. It is part of the capsule of the joint. It is attached to the articular margins of the femur and tibia on their medial aspects and is continuous with the capsule of the knee joint in front and behind. It is attached intimately to the medial meniscus. The superficial part, which is by far the larger and the more important, arises below the adductor tubercle from the medial epicondyle of the femur and is inserted into the medial condyle of the tibia, and into the posterior part of its subcutaneous surface for a distance of one handsbreadth below the level of the knee joint. It is a broad, flat, triangular structure, and is very strong. Its anterior border is vertical, but its posterior border is oblique in opposite directions above and below the joint, so that the widest part is over the medial meniscus (Fig. 2). Posteriorly it overlaps the deep part (short internal lateral ligament described on page 683), and in this situation its fibres are attached firmly to the medial meniscus; its anterior border is free of attachment to the meniscus. According to Bland Sutton (1884) the anterior vertical part is, morphologically, the degenerated tendon of adductor magnus. The hamstring part of adductor magnus (the presemimembranosus muscle of Comparative Anatomy), which is inserted into the adductor tubercle. From this point downwards it is represented by the vertical part of the medial ligament of the knee joint. The deep or capsular, and the superficial or tendinous, parts of the medial ligament of the knee joint are fused into a single structure above, but they are separated below by an expansion from the semimembranosus tendon which passes forwards between them (Fig. 3). This is the expansion which is often described as being inserted into the medial meniscus; in our experience it is inserted only into the tibia. Still lower, the medial ligament is separated from the tibia by the passage beneath it of the medial inferior genicular vessels and nerve. Strong retinacular fibres from the medial border of the patella curve towards the anterior border of the upper part of the medial ligament (Fig. 2). In flexion of the joint the anterior edge of the medial ligament passes backwards, thus exposing a greater extent of the medial meniscus.

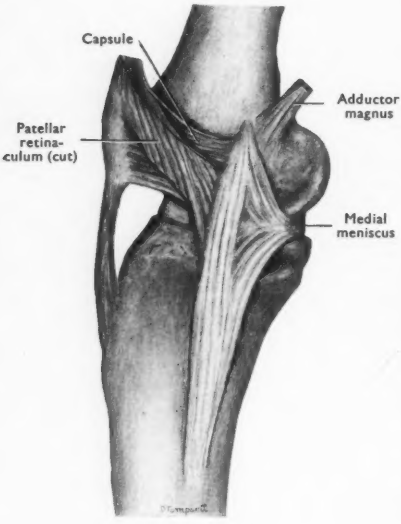

FIG. 2
The medial ligament of the knee joint.

Tension of the ligaments—Both medial and lateral ligaments of the knee joint are taut in extension, their upper attachments being placed behind the axis of rotation of the femoral condyles. They are relaxed in flexion. In flexion, moreover, a smaller surface of the femoral condyles is in contact with the tibial plateau. These two factors are responsible for the greater degree of mobility of the joint in flexion, viz., rotation and passively induced adduction and abduction. The state of the cruciate ligaments in flexion contributes to this increased mobility (*vide infra*).

Foetal capsule in the adult joint—Between the medial and lateral ligaments, across the front of the joint, the foetal capsule is still present with its circular gap filled by the articular surface of the patella. From the lower margin of the patella to the anterior margin of the plateau of the tibia the capsule is separated from underlying synovial membrane by a pad of fat which herniates into the joint and raises a median fold called the ligamentum mucosum,

extending into the joint as far as the anterior surfaces of the cruciate ligaments. Two alar folds extend, one on each side of the ligamentum mucosum. They have no morphological significance. The statement that they are relics of intra-articular septa is wrong. There is no evidence that primitive septa ever existed in any vertebrate knee joint (Wheeler Haines 1941). The original capsule above the patella, between it and the femur, perforates when the infant walks and thereafter communicates with a large suprapatellar bursa lying deep to the quadriceps tendon, and in the adult limb extending a handsbreadth above the joint.

Thus the foetal capsule is still present in the adult joint; it has two gaps, one allowing the popliteus tendon to emerge, and the other communicating with the suprapatellar bursa. Other gaps in the capsule for communication with bursae may occur, but they are inconstant. The added ligaments provided by the phylogenetically degenerated tendons of adductor magnus and peroneus longus, the medial and lateral ligaments respectively, greatly strengthen the joint. Posteriorly the joint is also reinforced; an expansion from the tendon of insertion of semimembranosus extends upwards and laterally across the posterior part of the true capsule. This is the oblique posterior ligament of Winslow; its upper attachment is to the lateral condyle of the femur and the intercondylar notch, rather above its margin, so that a prolongation upwards of synovial membrane encroaches a little on the popliteal surface of the femur. Loose bodies may lodge here, and elude discovery at operation. The oblique posterior ligament is a thick rounded cord of great strength (Fig. 3—The figure does not show several irregular prolongations which extend from the ligament to the popliteal surface of the femur and give rise to a fenestrated appearance above the main ligamentous band).

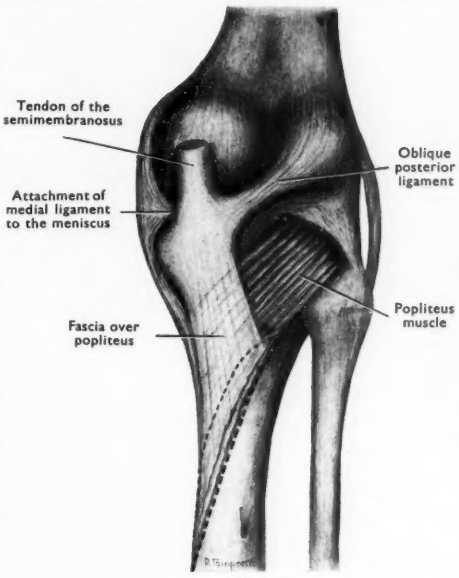

FIG. 3
Posterior aspect right knee joint. Dotted line indicates attachment of soleus.

INTRA-ARTICULAR STRUCTURES

Cruciate ligaments—The cruciate ligaments consist of a pair of very strong bands connecting the tibia to the femur, and they lie within the capsule of the knee joint but not within the synovial membrane. It is as though they had been herniated into the synovial membrane from behind, carrying forward over themselves a fold of synovial membrane which invests their anterior and lateral surfaces, but leaves their posterior surfaces uncovered except superiorly. They are named from their tibial origins, and cross like the limbs of the letter "X." They are essential to the stability of the knee joint. The anterior cruciate ligament is tense in extension, the posterior tense in flexion, but neither is really lax in any position of the joint. Lateral rotation of the flexed tibia unwinds them; medial rotation winds them up.

Medial and lateral menisci—The menisci consist of fibrocartilage, curved in shape and wedge-shaped in cross section. They are avascular except for a narrow zone at their points of attachment (Davies and Edwards 1948). The medial meniscus is attached to the tibia at its anterior and posterior horns by fibrous tissue; elsewhere the circumference is attached strongly to the capsule and posterior part of the superficial medial ligament of the knee joint (Fig. 2). The lateral meniscus is likewise attached to the tibia at both horns; in addition

its posterior horn is slung by fibrous tissue "ligaments" to the femur. The slings are attached to the medial condyle of the femur, in front and behind the attachment of the posterior cruciate ligament, forming the ligaments of Humphry and Wrisberg respectively (Figs. 4 and 5). These ligaments are strong structures, especially the latter, and it is unfortunate that their names should have been dropped from current British nomenclature.

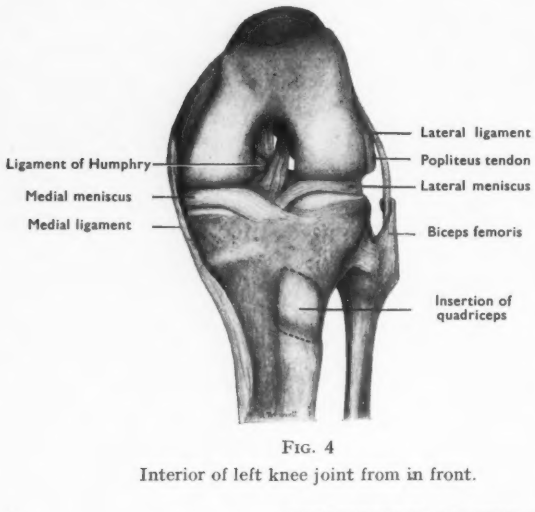

FIG. 4
Interior of left knee joint from in front.

The lateral meniscus is thus fixed at its horns, but elsewhere it is freely mobile, being separated from the deep part of the lateral ligament (capsule) of the knee joint by the tendon of popliteus (Fig. 1). Firm attachment of the arcuate ligament to the meniscus, and attachment of the upper fibres of the popliteus muscle to the arcuate ligament and meniscus, ensure backward drawing of the posterior arch of the meniscus in medial rotation of the flexed tibia. It is the moving backwards of the meniscus in medial rotation of the leg which rounds off the posterior edge of the lateral tibial condyle, and not the tendon of popliteus, as stated in most current texts.

MOVEMENTS AT THE KNEE JOINT

Flexion of the joint is limited by the soft parts behind; extension is limited by tension of the medial and lateral ligaments, and the anterior cruciate ligament. Full extension is accompanied by lateral rotation of the tibia, a movement which is to some degree passive, resulting partly from the shape of the articular surfaces (the lateral femoral condyle being shorter than the medial, so that it is "used up" first) and partly from the pull on the tibia of the lowest fibres of vastus lateralis. In flexing the joint from this locked position the popliteus begins the movement by medially rotating the tibia. Popliteus, and the lowest fibres of vastus lateralis, are thus antagonists. When the joint is flexed, medial and lateral rotation of the tibia are performed by the hamstrings. The freedom which allows this rotation of the tibia results from relaxation of the medial, lateral and anterior cruciate ligaments; greater mobility also results from the fact that a smaller femoral surface is in contact with the tibial plateau in flexion. In this flexed position the posterior cruciate ligament is taut and it forms the axis around which the tibia rotates on the femur. In flexion and extension the menisci, fixed to the tibia, move with it on the femur. In rotation of the tibia in the flexed position the menisci, especially the lateral, move with the femur on the tibia. This is a characteristic feature of all joint fibrocartilages in which two separate, but often simultaneous, movements take place—for

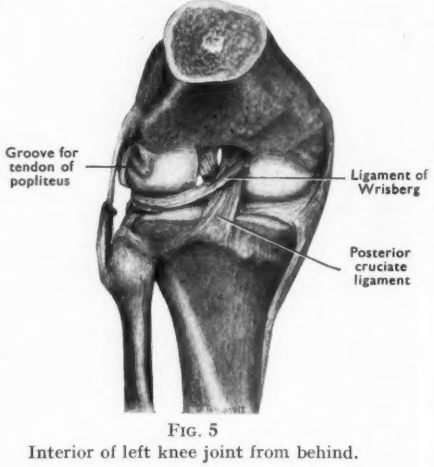

FIG. 5
Interior of left knee joint from behind.

example the temporo-mandibular joint which has gliding movement in its upper compartment and true hinge movement in its lower; and the sterno-clavicular joint which permits up and down movement of the clavicle in the lateral compartment, and horizontal or rotary movement in the medial compartment. It is substantially true of the knee joint that flexion and extension take place in the upper compartment while rotation takes place in the lower. The menisci also play an important part in spreading the lubricating film of synovial fluid (MacConaill 1931).

MUSCLE ATTACHMENTS NEAR THE KNEE JOINT

Careful dissection shows that some accepted descriptions of muscle attachments in the region of the knee joint are inaccurate.

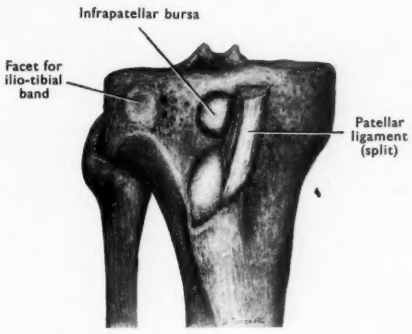

FIG. 6

Anterior aspect of the head of tibia.

Quadriceps femoris—The four components of this muscle are inserted into a trilaminar quadriceps tendon. Anteriorly, the rounded tendon of rectus femoris flattens immediately above the patella, and forms the anterior lamina which is inserted separately at the anterior edge of the upper border of the patella. In the middle of the thigh, contiguous surfaces of the rectus femoris and vastus intermedius are each covered by a shining aponeurosis. The aponeurosis which covers the surface of vastus intermedius is continued downwards as the deepest lamina of the quadriceps tendon; it is inserted into the posterior edge of the upper border of the patella. The intermediate portion of the tendon is a lamina formed by confluence of the central edges of the vastus lateralis and vastus medialis. The lowermost fibres of vastus medialis, almost horizontal in direction, do not contribute to the quadriceps tendon. They are inserted directly into the side of the patella, and exert an indispensable influence in preventing lateral displacement of the patella during contraction of the quadriceps. It is these lowermost fibres of vastus medialis which atrophy so rapidly in affections of the knee joint such as acute synovitis. The ligamentum patellae is inserted into the tibia over the smooth, rounded part of the tubercle of the tibia—the part, that is, which is on the epiphysis. The area is limited above by an oblique groove which receives a very substantial portion of the ligamentum patellae (Hughes 1946). The infrapatellar bursa lies, not over the smooth part of the tubercle, but over the rough, pitted anterior surface of the head of the tibia immediately below the transverse ligament (Fig. 6).

Biceps femoris—The tendon of biceps is not " split " by the lateral ligament of the knee joint. It wraps around the posterior part of the lateral ligament; the deep part of the tendon lies between the lateral ligament and the true capsule of the joint (between the long and short external lateral ligaments of old terminology). The superficial part of the tendon of biceps wraps around the superficial part of the cord-like long external lateral ligament, and it is attached to the lateral margin of the head of the fibula and sends an expansion across the superior tibio-fibular joint to the tibia.

Popliteus—From the rounded tendon of origin the fan-shaped muscle emerges beneath the arcuate ligament and diverges towards its insertion on the popliteal surface of the tibia. Although seldom described, it is true that a very substantial portion of this muscle arises not from the tendon of popliteus but from the arcuate ligament itself. Some of the uppermost fibres actually arise from the lateral meniscus, a fact which has been noted in very few texts.

Moreover, the muscle fibres which truly leave the tendon and pass beneath the lower part of the arcuate ligament are firmly adherent thereto (Figs. 1 and 3); their attachment to the arcuate ligament draws the muscle up in a sinuous manner which disappears when the arcuate ligament is itself dissected away. Consequently the true attachment of popliteus cannot be made out when the muscle is " cleaned " for a museum specimen.

Protection of the lateral meniscus from injury—It is suggested that the attachment of popliteus to the lateral meniscus (both directly, and indirectly by way of the arcuate ligament) is the primary factor in protecting the meniscus from injury. It is not the mobility *per se* of the lateral meniscus which makes it relatively immune from injury, but rather the *controlled* mobility gained by the ligaments of Humphry and Wrisberg and, especially, the popliteus muscle. In flexion of the knee joint a smaller surface of the femoral condyle articulates with the tibial plateau; consequently the menisci are not likely to be nipped between the articular surfaces during uncomplicated flexion. But in the flexed position, when lateral rotation of the femur on the tibia takes place (around the axis of the posterior cruciate ligament) the lateral femoral condyle glides posteriorly along the lateral articular surface of the tibia. It does not push the posterior arch of the lateral meniscus out of the way; the meniscus is actively pulled away by the popliteus muscle and by the pull of the ligaments of Humphry and Wrisberg. It is not the tendon of popliteus but the lateral meniscus which bevels the posterior margin of the lateral tibial condyle. The synovial membrane is prolonged from the joint as the popliteus bursa, which lies deep to the muscle, between it and the tibia. It often communicates with the superior tibio-fibular joint. Fixation of the posterior surface of the popliteus muscle to the arcuate ligament precludes the formation of any bursa on the superficial aspect of the muscle. It is possible that the primary origin of the muscle was from the fibula and that its ascent to the femur in man is a secondary event (Taylor and Bonney 1905).

Soleus—The tibial origin of soleus is usually stated to be the soleal line and the middle third of the medial border of the tibia. Actually the muscle has a much more generous origin. Only the strong aponeurosis on the deep surface of soleus arises from the soleal line. It will be seen that this line has two ridges—one above and one below. To the upper ridge is attached the popliteus fascia, derived from the semimembranosus tendon; to the lower ridge the aponeurosis on the deep surface of soleus is attached. The fleshy fibres of soleus arise from an area above the soleal line on the popliteus fascia (Fig. 3).

Ilio-tibial band—As is well known the fascia lata attaches around the tibial condyles. Less generally appreciated is the fact that the ribbon-like condensation which constitutes the ilio-tibial band is received into a smooth non-pitted facet which stands out prominently on the front of the lateral tibial condyle. This facet marks the insertion, therefore, of three-quarters of the gluteus maximus muscle in addition to the tensor fasciae latae (Fig. 6).

Acknowledgment—The author wishes to express his appreciation of the work of the Prosector to the Royal College of Surgeons, D. H. Tompsett, Ph.D., who not only made many of the dissections (which will be incorporated into the Human Anatomy Section of the Museum) but also drew the illustrations.

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FROM AN ATLAS OF GENERAL AFFECTIONS OF THE SKELETON

5. DYSCHONDROPLASIA

Synonyms—Ollier's disease, Multiple enchondromata

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Dyschondroplasia is a somewhat rare developmental error, characterised by rounded masses or columns of unossified cartilage in the metaphyses and diaphyses of certain bones. It was first described and named by Ollier in 1900. An admirable review of the subject was published in 1935 by Hunter and Wiles.

It is often linked with diaphyseal aclasis, as pointed out in the section dealing with that affection, the two conditions being regarded as variants of the same fundamental developmental error. This may lead to confusion which is quite unnecessary: though both result from a fault of the epiphyseal line, nests of cartilage becoming misplaced instead of being calcified and ossified in the normal manner, they are radiologically and in other ways quite different and in the vast majority of cases are readily distinguishable. In the condition to which the author prefers to confine the term dyschondroplasia, masses of cartilage are found inside the metaphyses, the lesions being essentially endosteal and not projections on the surface, as are exostoses.

Hereditary and familial influences—These influences play no part in the incidence of dyschondroplasia as they do so commonly in diaphysial aclasis.

Sex—Both sexes are affected, males rather more frequently than females (Stocks and Barrington 1925).

Age—The diagnosis is usually made in childhood: in exceptional cases the shortness of an affected limb may be noticed at birth.

Etiology—The cause is unknown: it is said to act between the fourth and eighth months of foetal life (Speiser 1925) but there seems to be no doubt that in many cases it must have been active at a later date. Bentzon (1924) pointed out that the columns showed a tendency to radiate towards the epiphyseal line from the point of entry of the nutrient artery (*e.g.*, in the upper tibia) and he suggested that the cause might be hyperaemia due to anomalies of the vegetative nervous system. A number of experiments were carried out to prove this theory, but without convincing success.

Distribution—There is a strong tendency towards unilateral distribution of the lesions, though seldom strictly so. Enchondromata of one hand are commonly associated with a few enchondromata in the opposite hand, particularly in the thumb and little finger, with or without one or two in other bones. Enchondromata may, however, be confined to a single bone, or to some bones of a single limb. The two lower limbs only may be affected. In rare instances, all four limbs show fairly extensive changes. The bones chiefly involved are the long bones formed in cartilage and, as in the case of diaphyseal aclasis, it is at the more rapidly growing ends of these bones that the " lesions " are most often seen. The region of the knee joint and the lower ends of the radius and ulna are particularly common sites, but enchondromata are quite common at the upper ends of the femur and humerus respectively, and at the lower ends of the tibia and fibula. In the upper femur, columns of cartilage radiating from the lesser trochanter are not uncommon. As in so many developmental errors the region of the elbow joint is singularly free from changes. The long bones of the hands and feet, particularly the phalanges, are favourite sites for numerous enchondromata which are frequently the cause of obvious and disabling deformities. Dyschondroplasia

differs markedly in this respect from diaphyseal aclasis in which phalangeal exostoses are few and insignificant. The pelvis is a common site, the scapula rather less so. The ribs, sternum, and skull are seldom affected and the tarsus very seldom. The carpus and the spine usually escape; but the sacrum in one of our cases was affected on both sides, in addition to the ilium and pubis on one side. The middle part of the shaft of a long bone is seldom the site of lesions; when this does occur it is usually, but not exclusively, in the most severe cases: the occurrence of changes in the mid-shaft suggests that errors in development must have been active in foetal life.

Clinical signs—In typical cases the affected arm and leg are *dwarfed* to a varying degree; sometimes they are grossly dwarfed. In a youth of eighteen years the affected lower limb was ten inches shorter than the other. When one half of a metaphysis is occupied by columns of cartilage to a greater extent than the other, the rate of growth at the corresponding half of the epiphyseal line is often retarded. In this way *deformities* such as genu valgum may develop, in addition to general shortening of the affected limb. Deformity caused by large enchondromata in the phalanges is very common: in extreme cases a hand may be practically useless. As in diaphyseal aclasis, and certain other affections, the ulna frequently displays a greater degree of shortening than the radius: in these circumstances the shaft of the radius may be curved, and occasionally the radial head is dislocated. There may be cubitus varus at the elbow and inward displacement of the hand at the wrist. Seldom is the radius the shorter of the two bones. The fibula may be shorter than the tibia, without producing deformity of the latter bone. Facial asymmetry is sometimes present (Hunter and Wiles 1935). Involvement of cranial nerves, including the optic nerve, was reported by Nielson (1941). Fractures are distinctly uncommon except in severely affected phalanges. *Blood examination* reveals no abnormality.

Radiographic appearances—In the metaphyses, radiographic examination reveals cartilage-filled clear spaces of varying size and shape but with a marked tendency, except in the hands and feet, towards a columnar arrangement, the columns extending a varying distance into the shaft of the bone. The density of bone between cartilage columns is often increased, and these intervening bony septa may give rise to a striated or streaky appearance in the affected metaphysis. There seems to be no sufficient reason, however, for linking the condition of striated bones reported by Voorhoeve (1924) with dyschondroplasia and osteopoikilosis, as suggested by that author. The shaft of a major long bone, with the metaphyses at both ends severely affected, besides being unduly short is often thick and dense. Only rarely is the shaft of a major long bone extensively involved: in such a case the mottled, cyst-like changes may give rise to difficulty in diagnosis and call for biopsy, unless the hand or foot shows typical changes. An affected metaphysis may show little if any distortion of shape, but in well-marked cases some enlargement is usual and occasionally this is gross. Not infrequently there is curvature of the affected part of the bone, particularly when the cartilage columns are confined more or less to one side of the metaphysis. When a metaphysis is distended by large masses of cartilage these often protrude through the cortex. A breach in the cortex may also be caused by a relatively small column of cartilage: this may be seen not infrequently in a shaft, some distance from the epiphyseal line. If more than a nipple-like projection is formed, the gap in the cortex is often limited on one side by a sharp bony point which may be mistaken for an exostosis. Cortical projections formed in this way point towards the epiphyseal line, whereas true exostoses are always inclined in the opposite direction towards the centre of the shaft. Occasionally a small islet of cartilage is seen lying *in* the cortex of a long bone. The way in which normal growth and modelling of a metaphysis may cause protrusion of an enchondroma, which was originally completely endosteal and which has not materially increased in size, is well illustrated by Langenskiöld (1947). Though enchondromata and exostoses may be associated occasionally in the same case,

we believe that this combination is very rare indeed, and in fact much more rare than some authors would have us believe. In younger children the epiphyses usually show no abnormality but in older children, even from five years upwards according to Hunter and Wiles, irregularity in density with mottling and occasionally streaking of some epiphyses may be seen. In one of our cases, dense mottling of several epiphyses was a striking feature in films taken before the age of three years. These epiphyseal changes are not uncommonly confined to half an epiphysis, and are never seen unless the corresponding part of the metaphysis is the seat of definite changes. In the adult, abnormal streaking still visible in the shaft of a bone may be seen to extend into what was the epiphysis. In the digits, distension and loss of continuity of the cortex over one or more chondromata is very common; and the chondromata may occur anywhere in the shafts of these bones, showing much less preference for the metaphyses and no tendency to a columnar arrangement. The commonest site in the pelvis is the ilium, near the crest, though chondromata may be seen in the pubis or ischium. The typical appearance in the ilium is that of clear columns radiating in a fan-like manner towards the crest. In two of our cases, both ilia were affected.

In older children and adolescents dense spots are seen scattered throughout an affected metaphysis, and even in the adjacent epiphysis or part of it. There is loss of definition of the cartilage columns and a general suggestion of ossification and healing; this transformation is usually well advanced by the time skeletal growth has ceased. According to Hunter and Wiles (1935) these changes are seldom seen till after six years of age. Dense spots found in a child of two and a half years (Figs. 101–103) appeared at an exceptionally early age. Though such dense spots are found in enchondromata in the fingers, the tendency to arrested growth and to ossification is much less evident in these bones than in the major long bones.

Progress and complications—As a rule there is little tendency, except in the hand and foot, for the masses of misplaced cartilage to proliferate. In the fingers, the presence of many enchondromata of considerable size, fungating through the cortices, may eventually cause complete crippling of the hand. In a man of thirty-two years the total width of the fingers in a completely useless hand amounted to seven and a half inches. As already indicated, there is usually little tendency for the cartilage columns to calcify and ossify before adolescence is approached. In a major long bone proliferation of an endosteal nest of cartilage occasionally continues after growth has ceased, but this is very unusual. Even more rare is the development of a chondro-sarcoma. It is not always easy to determine whether such a growth has arisen endosteally, or started in the cartilage cap of an exostosis: the latter appears to be distinctly the more common of the two. The upper part of the humerus and the pelvis are sites at which chondro-sarcomata of apparently endosteal origin have been reported. Excessive enlargement of a mass of misplaced cartilage, except in the digits, is more common when the mass is solitary. Willis (1948) considered that a solitary chondroma, like a solitary exostosis or osteoma, should be regarded as a neoplasm and not as an isolated result of the developmental error we are discussing here.

Pathology—Histologically the masses consist of hyaline cartilage with cells of varying size, some abnormally enlarged, arranged in a somewhat irregular manner. There may be septa of fibrous tissue. Calcification and ossification of the cartilage may be seen, particularly in older patients. In the larger chondromata, signs of degeneration may be evident.

Diagnosis—Advice is usually sought because there is deformity. Radiographic examination then reveals the true nature of the case. The interpretation of radiographs of a single bone, particularly in adults, may be very difficult: the appearances may be misleading. But, when all the radiographic evidence is examined the diagnosis is usually easy. Films of the digits are particularly helpful in doubtful cases. In osteopoikilosis the dense spots in metaphyses and epiphyses which are a feature of the condition are not confined to two limbs, as is so often the case with dyschondroplasia; moreover in that condition, apart from the spots, the

bones are normal in density and outline. Only occasionally is biopsy advisable. Osteotomy for the correction of deformity, when it is called for, gives the surgeon an opportunity to confirm the diagnosis. After osteotomy, the fragments unite readily.

MAFFUCCI'S SYNDROME (1881)

This is a condition in which dyschondroplasia is associated with cavernous haemangiomata and phleboliths in the soft tissues. Carleton *et al.* (1942) gave an admirable review of the twenty cases published in the literature and reported two cases of their own. In the first of these, a group of phleboliths was seen in relation to irregular enlargement of the anterior surface of one tibial shaft. Except in this case, and one published by Krause (1944) in which all lesions were confined to one side of the body, the bone and soft tissue lesions seem to be entirely independent in their distribution.

I wish to express my sincere thanks to colleagues and friends who have supplied me with details of cases under their care. Some of the illustrations are reproduced by courtesy of the British Journal of Surgery.

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CASE 31—DYSCHONDROPLASIA—Both lower limbs

(Fig. 94.) Girl, aged four and a half years. Left leg bowed due to deformity of the femur, and all major long bones of the limb shorter than on the right. Arms and hands not affected. Enchondromata in the right ilium—very slight (and none at all in the left ilium) and at the ends of the femur, tibia, and fibula of both lower limbs, the changes being much more marked in the left. Though the distribution of lesions is unusual, this case shows particularly well the columnar arrangement of changes in the metaphyses (Under Dr Donald Paterson).

FIG. 94

Case 31. Lower limbs showing characteristic changes in the metaphyses. The tendency to columnar arrangement of the cartilaginous masses is well shown. Irregular density and mottling are seen in several epiphyses. Note that only the inner half of the epiphysis of the right femur is mottled and only the inner half of the metaphysis contains columns of cartilage.

CASE 32—DYSCHONDROPLASIA—Almost completely unilateral

(Figs. 95–100.) Male. Shortness of the left arm and leg noticed at birth. No other members of a large family affected. When seen in 1925 at the age of twelve years (then under the late Dr Gordon Pugh) there was marked shortening of the left arm and leg. Enchondromata were visible on the left side in the lower angle of the scapula, both ends of humerus, lower ends of radius and ulna, hand (numerous), ilium, both ends of femur, upper ends of the tibia and fibula, and long bones of the foot. On the right side cartilaginous nests were seen only in the ilium and the little finger. Lesions in the major long bones showed typical columnar arrangement with already a few dense foci of calcification and ossification in some metaphyses. In 1946, at the age of thirty-three years, he was again seen when in the care of Mr J. S. Batchelor. Shortening of the affected limbs was marked. Dense mottling and loss of definition of the lesions, indicative of attempts at "healing," were most striking when the films were compared with those taken in 1925. This change was most obvious in the metaphyses of the major long bones, but there were many intensely dense spots in the enchondromata of the left hand which was grossly deformed and practically useless: it measured seven and a half inches across the fingers. Lesions were then visible in the right thumb and lower end of the right radius. All other lesions had been recognised twenty-one years earlier. (Reported by Fairbank, H. A. T. (1927), British Journal of Surgery, **15,** 120; and Rae, J. L. (1936), Proceedings of the Royal Society of Medicine, **29,** 1665.)

FIG. 95

Case 32. Left forearm, at the age of twelve years, showing typical endosteal cartilaginous columns deforming the metaphyses of both radius and ulna, and irregularity in the density of their respective epiphyses. The bones are short, thick, and strong—the ulna, as usual, being the shorter of the two. Only a few dense spots of ossification are visible in the affected part of the radius. Note that the carpus is unaffected.

FIG. 96

Case 32. Left knee at age of twelve years, showing gross changes indicative of dyschondroplasia in the metaphyses of all three bones. Typical columnar arrangement of the cartilage masses is well seen in the tibia. Dense spots of ossification are visible in the femur. The epiphyses of the two major long bones are not affected but that of the fibula is somewhat mottled. What appears to be a small exostosis is seen on the inner side of the tibia.

FIG. 97

Case 32. Hands at the age of thirty-two years showing enchondromata in every bone of the left hand, with innumerable dense spots of calcification. The lower ends of the radius and ulna appear to be "healed." In the right hand there are enchondromata only in two digits and their corresponding metacarpals. The lower end of the right radius is deformed but there is no change on which a diagnosis could be made with certainty.

FIG. 98

Case 32. Pelvis at the age of thirty-three years showing "healed" lesions in both ilia, the left pubis, and the left great trochanter.

FIG. 99

FIG. 100

Case 32. Fig. 99 shows the left knee at the age of thirty-three years; there is great advance in ossification of the cartilage masses as compared with the film taken at the age of twelve years (Fig. 96). Fig. 100 shows the left ankle and foot at the age of thirty-three years; there are densely calcified spots in the lower ends of the tibia and fibula and in the phalanges. The tarsus shows changes which are not characteristic of any particular dysplasia.

CASE 33—DYSCHONDROPLASIA—Bilateral to a greater degree than usual, all four limbs markedly affected

(Figs. 101–103.) Girl. One other child, a male, died of hydrocephalus at the age of three years. First observed when seven months old. Deformities have progressed steadily ever since, and are now gross at the age of two years and eight months. (Under Mr R. G. Pulvertaft.)

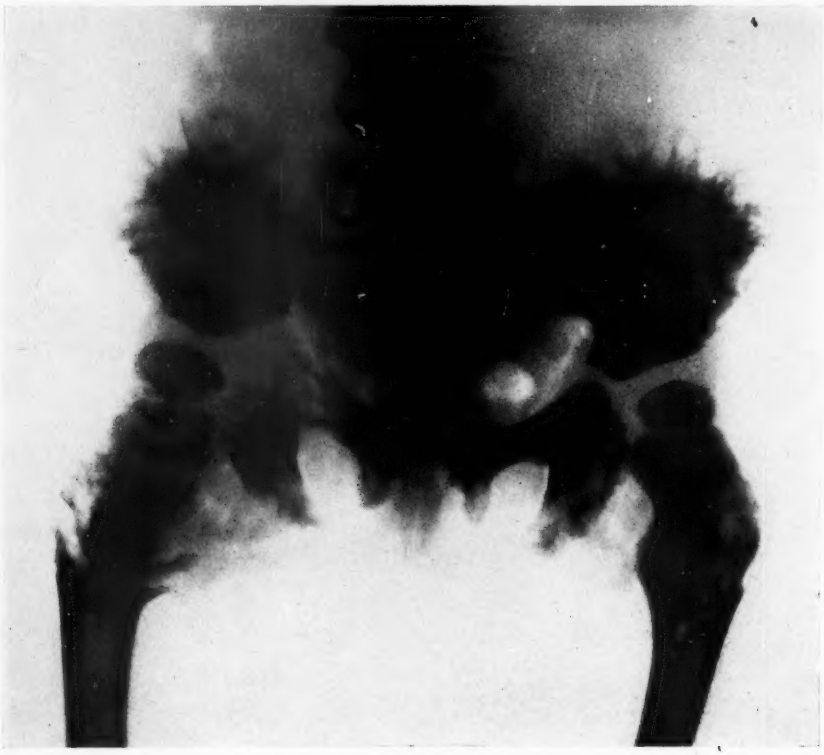

FIG. 101

Case 33. Pelvis at the age of two years, showing typical radiating columns of cartilage near the crests of both ilia, and enchondromata in both ischia, right pubis, and both femora.

FIG. 102

Case 33. Hands at the age of two and a half years, showing numerous typical enchondromata in both extremities to an approximately equal extent. The multiple dense centres of ossification in the cartilage at the lower ends of the right radius and both ulnae is most unusual at this early age, and gives an appearance not altogether unlike that seen in dysplasia epiphysialis punctata. Note that the shafts of the radii and ulnae are short and stout, the ulnae being as usual more shortened than the radii.

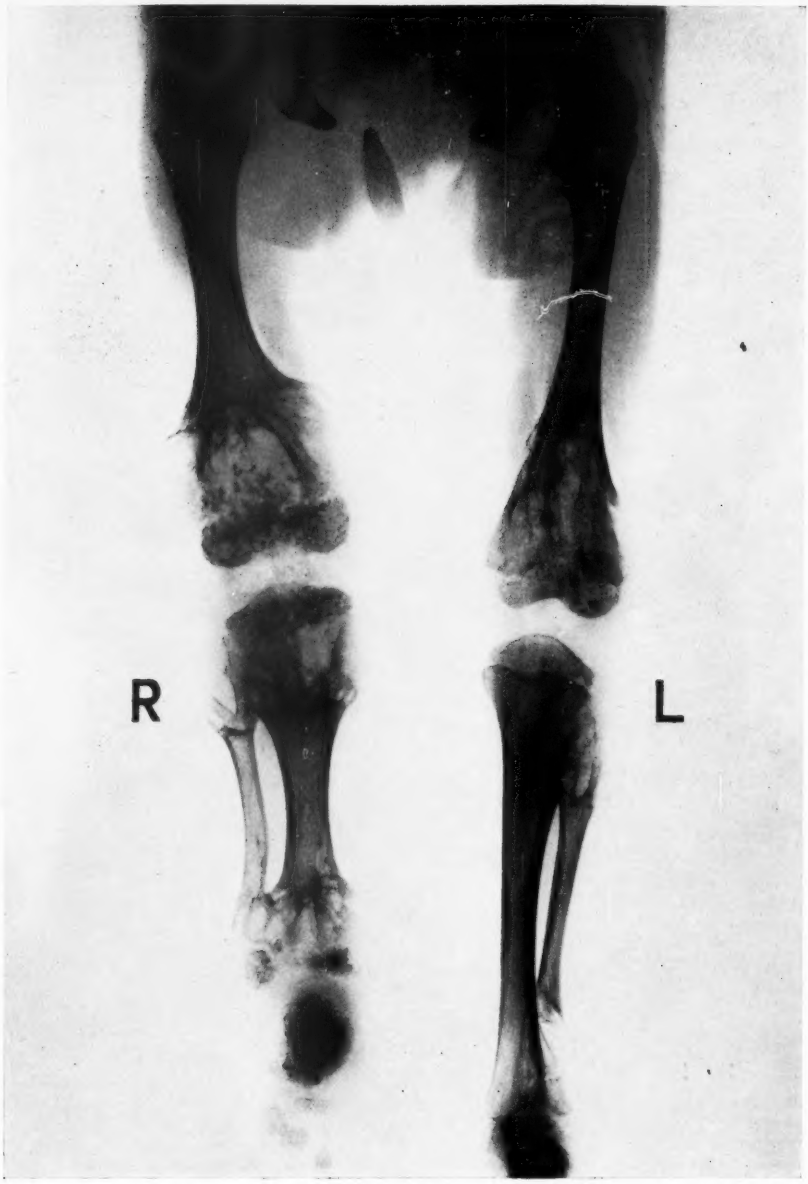

FIG. 103

Case 33. Lower limbs at age of two years eight months, showing all six major long bones affected with shortening of the right lower limb. Stippling, with dense ossific centres of the epiphyses and adjacent metaphyses, the latter largely cartilaginous, is a striking feature and is a most unusual appearance at this early age. Similar stippling can be seen in the right tarsal bones. Note the spikes formed by the cortex at the lower end of the shaft of both femora: in left leg the fibula is more affected and much shorter than the tibia.

CASE 34—DYSCHONDROPLASIA

(Figs. 104–106.) Male aged seventeen years. Right arm and leg affected. Gross interference with function of hand due to size and number of cartilaginous tumours. Particularly severe deformity of the leg. (Under Mr McCrae Aitken.)

FIG. 104

Case 34. Pelvis and femora, showing atypical changes in the shortened right femur. The considerable involvement of the shaft and the texture of the bone, particularly of the lower metaphysis, are unusual.

FIG. 105

Case 34. Right forearm and hand. The metacarpals and phalanges show many enchondromata. Those in the digits have proliferated to such an extent that one hand is hopelessly crippled. The carpus, as usual, is free from cartilaginous masses. The lower end of the radius shows a fairly typical appearance: several dense spots are seen. The ulna is surprisingly normal both in length and texture, but there is a cartilage mass in the upper part of the lower third.

FIG. 106

Case 34. Lateral view of right knee, leg, and foot. The grotesque deformity of the lower end of the femur is quite exceptional. Looked at alone, the diagnosis of this film would not be easy; but the affection is clearly metaphyseal and the numerous dense spots, well seen at the upper end of the tibia, suggest a diagnosis of dyschondroplasia. The curious outline seen at both ends of the tibia is probably not the result of fractures. Note that the tarsal bones, with the possible exception of the os calcis, are unaffected.

CASE 35—DYSCHONDROPLASIA—Incompletely unilateral distribution

(Fig. 107.) Male aged eighteen years. Right arm and leg markedly short and deformed. Never had osteotomy performed. Right leg ten inches shorter than left, due partly to deformity of femur and tibia. Unusual features were enchondromata in left pubis, as well as in both ends of left fibula, and *both* ends of the right ulna, with dislocation of the right radial head. There were a few enchondromata in the left thumb and little finger and many in the right hand. (Under Mr H. H. Langston.)

FIG. 107

Case 35. Right forearm showing the shortening and deformity of the ulna and the dislocation of the head of the radius.

CASE 36—DYSCHONDROPLASIA—affecting left forearm only

(Fig. 108.) Male aged nine years. Noticed deformity for three years. Recently complained that the arm pained him when working in the gymnasium. The "lump" was said to be increasing in size. Definite cubitus varus, with some prominence of the head of the radius. Left forearm one inch shorter than the right. Pronation limited by a quarter; supination free. Bony prominence on the front of the lower third of ulna. Humerus not shorter than right. No exostoses felt on any bone. No radiographic changes found except in this limb.

FIG. 108

Case 36. Shortened ulna with curious appearance and spots of calcification in the clear area in the head of the bone. Radius curved. Typical enchondromata in third finger confirmed the diagnosis.

CASE 37—DYSCHONDROPLASIA—Unilateral case

(Fig. 109.) Boy aged eleven years. Left upper limb and left lower limb very short. Bones of both these limbs contain many enchondromata which are particularly numerous in the left hand. Sacrum and left pubis are clearly affected as well as the left ilium. Upper metaphysis of the left humerus, and both ends of the left femur, show extensive changes. Dense spots of calcification and ossification are present in many of the cartilaginous masses; they are particularly numerous and closely packed at the upper end of the humerus. (Under Mr L. W. Plewes.)

FIG. 109

Case 37. Left forearm, showing a typical column of cartilage in the deformed radius, and fusiform enlargement at the lower end of the shortened ulna. Clear areas were also seen in the lower end of the humerus which is an uncommon site for enchondromata.

CASE 38—DYSCHONDROPLASIA—Atypical case

(Figs. 110–111.) Male aged fourteen years. Progressive limp in the right leg had been noticed since the age of four years. Four fractures had occurred in the shaft of the right femur in the last six years. There was café-au-lait pigmentation over the upper dorsal and lower lumbar regions of the spine. Total shortening of the right lower limb was no more than half an inch but this was because gross shortening of the right femur was compensated by lengthening of the right tibia and fibula. Biopsy of the right tibia was followed by a pathological fracture and later by fusiform enlargement of the shaft of the bone. Microscopic section showed only cartilage cells. Blood examination revealed no important abnormality. Well-marked though very atypical changes were seen in the right femur and tibia. Lesions which, though atypical, might have been enchondromata were also seen in the upper half of the shaft of the left humerus, the lower end of the shaft of the right ulna, in some phalanges of both hands, in the right ilium near the crest, both fibulae, the trochanteric region of the left femur, and possibly in the shaft of the left tibia. There was one spot of irregular decalcification in the centre of the left parietal bone seen in the antero-posterior radiograph of the skull. The distribution of lesions in the lower limb was not metaphyseal, but biopsy suggests strongly that this case should be classified as dyschondroplasia. (Under Sir Harry Platt and Mr A. F. Bryson.)

FIG. 110

FIG. 111

Case 38. The right femur (Fig. 110) shows a curious mottled appearance in the lower two-thirds or more of the shaft, and an old united fracture in the middle third of the shaft. The right leg (Fig. 111) shows unusual changes affecting most of the shaft of the tibia with fusiform enlargement at the site of a pathological fracture which occurred after biopsy. Somewhat similar changes, certainly not typical of dyschondroplasia, are seen in the upper and middle parts of the shaft of the fibula.

6. METAPHYSEAL DYSOSTOSIS

In this excessively rare condition the metaphyses of all long bones consist for the most part of unossified cartilage. The radiographic appearances are unique and they differ considerably from those seen in dyschondroplasia.

In 1934 Murk Jansen of Leiden published a case. Seven years before he had presented a set of radiographs of the patient, who was then five years of age, to the Royal College of Surgeons of England. By courtesy of Sir Arthur Keith, formerly Conservator of the Hunterian Museum, the author was able to secure prints of all the films. Search of the literature has failed to disclose a single comparable case.

The patient was a boy, born with club feet which were treated by manipulation. The ankles, and the lower ends of the radii and ulnae, gradually thickened. The child crawled at six months, but he was unable to walk at three years. Eventually, however, he succeeded in walking with the help of splints. He was dwarfed, and at ten years of age was at least twelve inches below normal height. The lower limbs were more affected than the upper limbs, and they were markedly deformed. The feet were valgoid. The skull and spine were normal. Dentition was somewhat delayed. At five years there was some anaemia, and the serum calcium was high (16·6 mgm.) but this gradually came down to 13 mgm. per cent. Other investigations of the blood and urine were negative. At ten years further investigations revealed no abnormality. Jansen considered that the cause was abnormal intra-uterine pressure acting at a particular stage of foetal development, a theory which he postulated in the explanation of other developmental errors.

Radiographic features—The epiphyses have developed remarkably well, and are of normal density, but the metaphyses both at five years and ten years of age are " still cartilaginous and irregular, cloudy and impregnated with salts." Some of the epiphyses are displaced from the lines of the shafts. This is more obvious in films taken at the age of five years than later. The shafts of the long bones are stout; many are curved, and they end very irregularly with some expansion. There is a wide interval between shaft and epiphysis, the space containing a varying number of rather dense and discrete centres of ossification, especially close to the shaft. There is no suggestion of a columnar arrangement of the cartilaginous metaphyses as in dyschondroplasia, and the epiphyses are not mottled, either partly or wholly, as they may be in the allied condition. The spots of calcification and ossification in the metaphyses vary in size, shape, and density, and they are not quite like the circular dense spots which are seen in the " healing stage " of dyschondroplasia. Many of the metaphyses appear to be enlarged. Changes in the hands differ strikingly from those of dyschondroplasia; the cartilage masses, dotted with fragments of bone, are seen only adjacent to every epiphysis and they are not distributed irregularly as isolated enchondromata anywhere in the shafts of the metacarpals and phalanges. The carpus and much of the tarsus seem to be ossified normally, but the posterior part of the os calcis shows changes similar to those in a metaphysis. At the age of five years, but not at ten years, irregular or punctate ossification is seen in the navicular and cuneiforms. In the pelvis the anterior parts of the ilia are mottled, but there is no such mottling, as one might have expected, in the bone near the crests. The skull, spine, ribs, and clavicles appear to be ossified normally.

Pathology—A fragment from the lower end of one tibia, including portions of the shaft and the cartilaginous metaphysis, was examined histologically. The cartilage cells were either small and collected into nests, or large and " myxoedematous." Calcification was seen in the matrix. The junction of diaphysis and cartilage was irregular, and isolated masses of bone were seen in the substance of the cartilage, " as in rachitis."

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FIG. 113

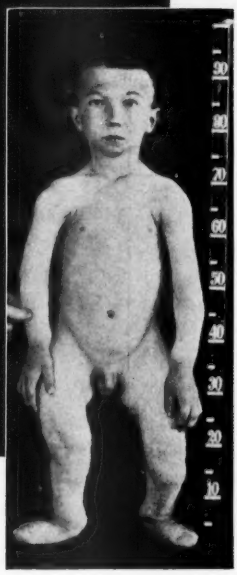


FIG. 112

Metaphyseal dysostosis

Case 39. The boy at the age of ten years, showing deformities of the lower limbs. Fig. 113 is a radiograph of the right shoulder joint and upper arm at the age of five years, showing the unossified cartilaginous metaphyses at both ends of the stout humeral shaft, the mottled centres of ossification at the upper end, and the well-ossified epiphyses at both ends. Fig. 112 shows the dwarfing, he was twelve inches below normal height.

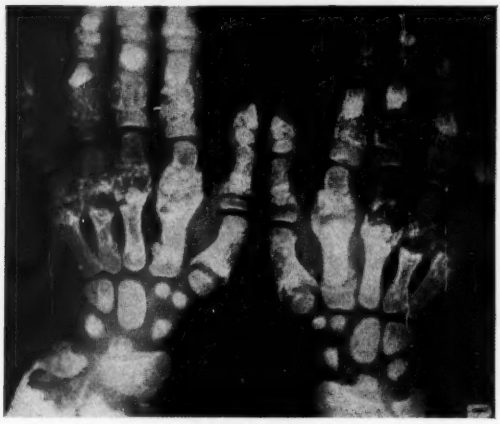


FIG. 114

Case 39. Hands at the age of ten years, showing the changes not scattered throughout the shafts as in dyschondroplasia, but concentrated almost entirely in the metaphyses. Note that the carpal bones are unaffected.

FIG. 115

Case 39. At the age of five years, showing irregular ossification of the anterior part of the ilia and the acetabula, and the stout curved femora with expanded upper extremities and largely unossified necks.

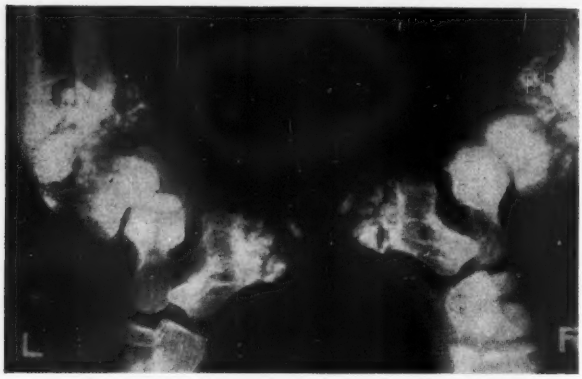


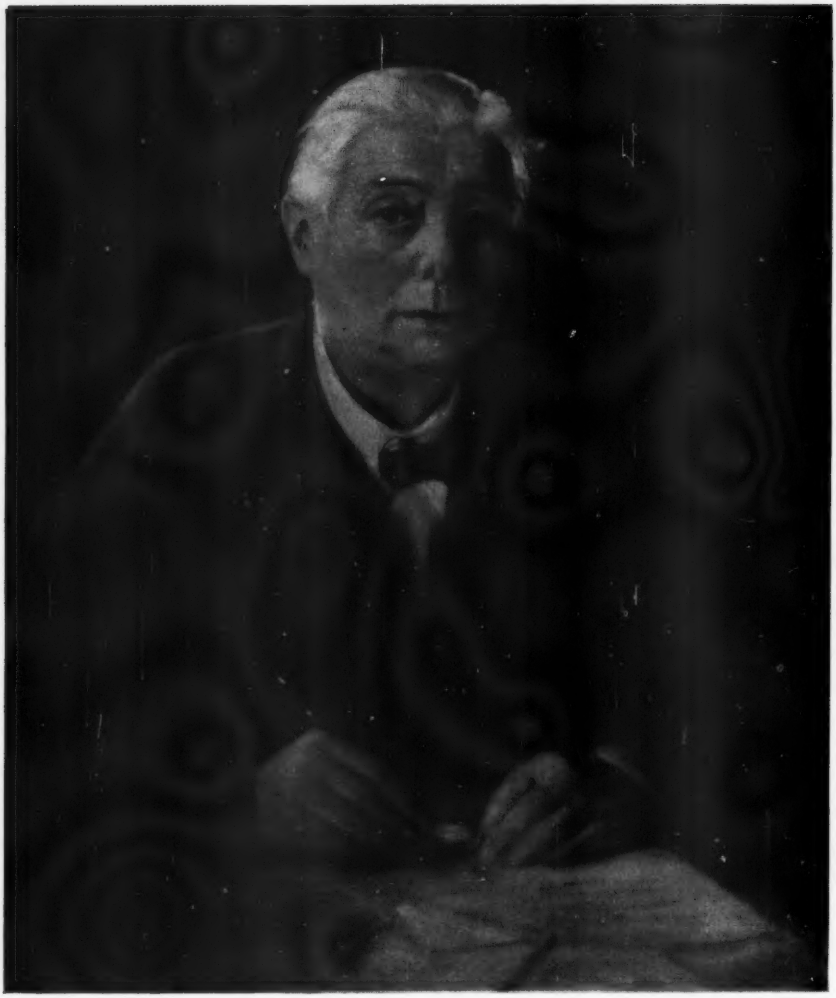
FIG. 116

Case 39. Ankles and feet at the age of ten years showing very irregular ossification and deformity of the lower metaphyses of tibiae and fibulae. Note well-formed epiphyses of these bones and irregular ossification of posterior part of the os calcis in both feet.

FIG. 117

Case 39. Knees at the age of five years, showing the stout femora, the unossified metaphyses with mottled centres near the diaphyses, and the well-ossified epiphyses of both the femora and tibiae. Note the displacement of the upper tibial epiphyses.

(Figs. 112, 114, and 116 are taken from Dr Jansen's article.)



Agnes Hunt
1867-1948

Dame Agnes Hunt

Believing that a fortune might be made in Queensland by breeding Angora goats, Mrs Rowland Hunt, widow of the Shropshire squire whose estate lay in fertile plains between the villages of Baschurch and Ruyton-Eleven-Towns, gathered those of her eleven children who still accepted an imperious domination and arrived in Brisbane, exactly sixty-five years ago, intent on the purchase of a desert island. No desert island was for sale. No Angora goats were in Brisbane—indeed there were none throughout the length and breadth of Australia; but Mrs Hunt refused to believe it and said that if there were no goats there ought to be. She did, however, weaken in her resolve and compromised by purchasing a fifty-acre paddock in which to rear chickens. The stock was not good, and many chickens were born with crippling deformities, but Mrs Hunt was undaunted and when she decided to amputate limbs with a carving knife and replace them with peg-legs made of Bryant and May matches it was the duty of her youngest daughter Agnes to administer the anaesthetic.

Agnes was then aged sixteen. She had been bred in a school of hard and rigid discipline. Her mother disliked children—" disliked them when they were coming, during their arrival, and most intensely after they had arrived." Her father " laughed immoderately at any accident." Her brothers induced a robust spirit of fearlessness; and the only governess who served the family with efficiency gave notice because the children " were allowed to kill themselves in too many different ways." When Agnes was aged ten she developed septicaemia and infective arthritis of the hip joint with high fever, sinus formation, and rapid destruction and dislocation of the joint; but within nine months her bath chair was harnessed to a pony which was raced until the chair was overturned, and within twelve months she was playing ice-hockey—on a home-made sledge, keeping goal. In later years she wrote of her mother: " Her psychology of childhood amounted almost to a crime but her treatment of me as a cripple was beyond praise. I was never allowed to pity myself or consider myself different. My brothers and sisters were never made to fetch and carry for me, and I joined in their play." It is true that at this age Agnes Hunt began her " apprenticeship to crippledom and the great education of pain "; she was destined to limp her way through life with stick or crutch; but already she had learned a first principle—the joy of life despite disability—and this was to be her great contribution to medicine.

When Mrs Hunt decided that the Australian continent had failed to live up to expectation, Agnes knew that " you might as well try to stop Niagara as stop my mother when once she had made up her mind." But a proud spirit of determination in the mother had been inherited by the daughter and, when Mrs Hunt decided to return to England, Agnes Hunt decided to stay in Tasmania to look after her brother Tom. She was influenced in this decision by an accident sustained by a young man who was felling trees. " In splitting a big tree, one of the wedges slipped and the great trunk closed over his hand, holding him fast. The poor lad's axe was just out of reach. He was found dead two months later and from the marks on his wrist he had tried to gnaw his hand off. I decided to stop."

In 1887, at the age of twenty, having received three proposals of marriage in one day—" not very eligible ones " she wrote " but still rather a record," she left the Tasmanian ranch and returned home with her brother. Training as a nurse began as lady-pupil at the Royal Alexandra Hospital in Rhyl, North Wales, and the West London Hospital, Hammersmith. Her one and only term of night duty was devoted to a midnight game of catch-as-catch-can round the wardroom table, chased by an epileptic madman who threw inkpots at her while she threw jugs of water at him. At that time nurses lived in primitive conditions and engaged in astonishingly long hours of duty; the evening meal consisted of bread, cheese, and beer.

The life was hard and arduous, and was indeed a sacrifice. So impressed was this young girl with the adverse conditions under which nurses served that she made a vow: " If ever I rise to be Matron, no girl shall ever be the worse in health because of her work among the sick. This vow I kept." This vow, Dame Agnes Hunt, you did indeed keep. To-day, in the Robert Jones and Agnes Hunt Orthopaedic Hospital the prowess of a nurse in the hockey field is almost as important as her skill in the operating theatre. Never was a staff of girls more able, more happy, and more ready to give of their best.

It was in Rhyl, on the sea-coast of North Wales, that two fundamental principles of the nursing of chronic illness were learned—open air and happiness. The Royal Alexandra Hospital was perhaps the first hospital for cripples ever to advocate fresh air as an integral part of treatment; and it was the teaching of Miss Graham, one of the founders, that " no nurse is worth her salt if she has not the joy of life within her and the power of sharing it with her patients." In due course Agnes Hunt qualified. She was awarded the Queen's badge and brassard, and spent a year in Northamptonshire nursing a typhoid epidemic. After resting in bed for six months on the instruction of a heart specialist she engaged once more as a district nurse in treating five hundred victims of a smallpox epidemic.

In 1900 " mother broke it to me that she was becoming old and deaf and intended to live with me. This was rather a blow." It was a blow because at first it appeared that the daughter's career of nursing might be ended; there could be no more travel and there could be no more responsibility as a district nurse. But, on reflection, this indomitable girl realised that it might still be possible to live at home and yet to nurse—and thus began the story of Baschurch, the pioneer convalescent home from which developed and spread throughout Great Britain and the world the ideals of country orthopaedic hospitals, after-care clinics, preventive treatment, and resettlement of the disabled. Now, in 1948, the vast resources of the Ministry of Health and the Ministry of Labour are engaged in the treatment and resettlement of nearly one million disabled persons. Orthopaedic hospitals and after-care clinics have been established throughout the country. Hundreds of orthopaedic surgeons and thousands of orthopaedic nurses, physiotherapists, almoners, and resettlement officers are solving the problems of the crippled and the disabled. But what was the beginning? The beginning was: " mother intended to live with me." A small and broken-down country house with an estate of no more than three-quarters of an acre was adapted. The drainage was primitive; the garden was so run-riot that it was a jungle and became known as the lion's den; there were a few cowsheds with broken walls and leaking roofs—this was the Baschurch Convalescent Home. Very soon the accommodation was unequal to the demand and stables and cowsheds were used for sleeping quarters. The sheds were more damp and draughty within than without, so that open-air treatment was quickly enforced. The lesson had been learned in Rhyl—open air and happiness. Open air was inevitable. Happiness may be judged from the pages of " Ye Olde Baschurch Cripples' Journal," produced in 1905 by two cripples and illustrated in colour by Mrs Rowland Hunt. The total circulation was two handwritten copies. An editorial, signed by Brother Aaron, reads:

> " What causes the most excitement is the picnics. We put the cripples on drays with springs and the others on wagonettes. When we have reached the spot planned, the horses are taken out and fastened to the trees and all the cripples who can't get about are put on rugs. Then we get sticks and put the kettle to boil and tea is ready in no time. We have a good game of something such as rounders. Those on crutches play as well but they are far more artful for when they are about a yard off the base they suddenly drop; of course the crutches reach it if they don't and they are let stand up as if they got there by fair means. All sing until they have hardly any breath left to sing the National Anthem. The people in the cottages all come out and by the look on their faces we could almost believe they wished to be ill just for the sake of the picnics."

There were picnics to the country and picnics to the seaside. The famous pony, Bobby, " the dearest and wickedest of ponies," made history for himself when he was so often left in sole charge of a cargo of cripples. Sir Frederick Kenyon recorded an incident in verse. Motor cars had recently been introduced; the roads of Shropshire were narrow; and the

Baschurch Home was out for a picnic as usual. Bobby met Jonathan Hustler's new car with its rush and hoot and roar.

"Bobby thought this is something new, something very unpleasant too! It may be right but I don't quite know, so back to home I am going to go. Round he turned with his precious load, and off he set in the middle of the road. The road was narrow, the road was long; Jonathan's language grew very strong. He hooted, he tooted, he shouted, he swore; Bobby went steadily on before. The neighbours laughed to see the sight; Bobby looked neither to left nor to right; till the dray and the whole of its cripple crew, safely back to the home he drew. When Jonathan started out that day, he swore that nothing should bar his way, though police traps in every hedge were hid, no bobby should stop him. But Bobby did."

Three years later, recurrence of infection in the hip joint made it necessary for Sister Hunt to consult Robert Jones in Liverpool. For some months thereafter she was immobilised on a Jones' abduction frame. "Immobilised" is perhaps hardly the term to use in relation to Agnes Hunt even when she was secured on a spinal frame with its bars, bandages, and traction tapes. "One day," she wrote, "soon after I had returned from the Royal Southern Hospital and was still on a frame, I drove the black cob in the dray to Shrewsbury to do my Christmas shopping. I had several cripples with me, one of whom was disabled only in the arm and could climb on and off the vehicle to ask the shopkeepers to come out. As luck would have it the cob was restive and a new bobby came up and asked 'Who is in charge of this horse?' With all the dignity I could muster I replied haughtily that I was. A frame is not an instrument that adds to one's dignity and the bobby's only answer was that he considered it unsafe and must take my name and address. I told him, and thinking to impress him added that I used to live at Boreatton Park. Unfortunately he knew this place only as a private lunatic asylum; my brother had let the house for that purpose some time after my father's death. The policeman remarked acidly that it was just the sort of place he would have expected me to come from."

This association with Robert Jones was a milestone by which the Baschurch Convalescent Home became an orthopaedic hospital. McCrae Aitken was at that time house surgeon at the Royal Southern Hospital, Liverpool, and he wrote: "There arrived from time to time in the out-patient clinic a woman, an outside porter from the railway station, and a home-made handcart like a baker's tray on perambulator wheels. The cart contained crippled children, perhaps as many as eight, in various forms of splints. The woman was Miss Hunt of Baschurch. A return train had to be caught so the party was soon inspected. Those requiring operative treatment were admitted; cases left at a previous visit were put on the handcart; it was as simple as changing books at the library." The outside porter was employed on arrival at Merseyside because this was so much cheaper than bringing an assistant from Baschurch. Even the perambulator wheels were of significance. The railway ticket for a child's perambulator cost only one shilling; the ticket for a handcart was much more expensive; and it needed only the good-humoured domination of Miss Hunt to persuade railway officials that this unusual form of transport was indeed a perambulator.

As work increased, Robert Jones himself went to Baschurch and operating lists were performed every month on the kitchen table. Doctor Urwick of Shrewsbury accepted the responsibilities of medical superintendent. More and more beds became available and the facilities were steadily improved. After the 1914–18 war a hutted Army hospital was taken over. Many original huts still remain and the private wing, known facetiously as Harley Street, consists still of the horse-boxes which were unwanted after the first war. Staff was gathered and the talent of Alwyn Smith, Girdlestone, Naughton Dunn, McCrae Aitken, and many other distinguished contemporary surgeons, made it certain that the Baschurch Convalescent Home should serve the county and become the Shropshire Orthopaedic Hospital, and in due course should serve the whole country and become the Robert Jones and Agnes Hunt Orthopaedic Hospital. Gradually, the hospital was rebuilt in accordance with Agnes Hunt's ideals. "I can see in my mind's eye a hospital with its long, low, one-storied wards and big French windows opening out on to lovely lawns, flowers, and big spreading trees.

Is this dream impossible? " It was not impossible; John Menzies saw to that. He was the man who was " found " by Sister Hunt, was inspired by her, and for so many years has served and is still serving faithfully as Secretary-Superintendent. Under his direction new open-air wards were built; the gardens, lawns, and trees which were imagined by Miss Hunt became a reality; and the laboratory facilities, X-ray equipment, and operating theatres which are essential features of a modern hospital became available. Consultants visit from Liverpool, Manchester, Birmingham, Cardiff, and London. The resident staff includes surgeons from England, Scotland, Ireland, Wales, Australia, Canada, South Africa, and the United States of America.

A short visit to this hospital may convey the same impression as a visit to any other important country orthopaedic hospital. Was this the contribution of Agnes Hunt? It was one of them; but it was perhaps the least. As early as 1907 it had become obvious that extensive accommodation and excellent facilities in the central hospital did not solve the problems of preventive treatment and follow-up supervision. Many families had spent their lives in the wilds of Blaenau Ffestiniog, or some remote hamlet, with a geographical horizon limited to a twenty miles' radius. Were they to be expected to travel with a crippled child to Shropshire, a journey which seemed as venturesome as one of the explorations of Columbus? And if initial fear was overcome, and the child was admitted to hospital, could the week-by-week supervision of after-treatment be continued over many months and years when every hospital visit called for one day's travel in each direction? It was not enough for the patient to go to the hospital; the hospital must go to the patient. And so a system of after-care clinics was established—a plan which may now appear obvious but which at that time called for vision, enterprise, and a complicated organisation. The first after-care centre was established in Shrewsbury, and as the influence of the hospital widened so were its outposts created. To-day, in an area which includes many counties, and covers hundreds of miles of rural and sometimes densely populated country, there are thirty-six after-care centres visited daily or weekly by orthopaedic nurses, physiotherapists, and social service workers, and at less frequent intervals by orthopaedic surgeons from the parent hospital.

In this activity Agnes Hunt was responsible for the development of a vast scheme of voluntary service which might well be recalled in this day of State direction and centrally planned health service. Every clinic is served by a County Voluntary Orthopaedic Association. Hundreds of women, previously untrained as nurses but quickly acquiring sufficient knowledge to recognise early cases, using their influence to ensure that such cases were brought within the ambit of the centre and thus applying themselves to the important tasks of preventive treatment, learning to carry out the instructions of orthopaedic nurses and orthopaedic surgeons, giving encouragement and moral support to cripples and their parents during long months and years of treatment, have devoted their lives and given whole-time service, five days a week, throughout the last thirty years. They were inspired by Agnes Hunt because she worked with them; she herself attended the clinics and was one of them. Let us hope and believe that this spirit of devotion which has been maintained for a full generation will not be dispelled, or even dimmed, by the reforms of hasty planning.

It was in 1927 that Sister Hunt succumbed to the stimulation of Robert Jones and agreed that the problem was not yet solved. It was not enough to search out cripples and arrange hospital and after-care treatment. Crippled adolescents must be taught not only the joys of normal recreation but also the responsibilities of normal work. A retraining scheme was necessary. She wrote: " I collected four boys, already training in the boot and blacksmith's shops, and two girls from the splint-making department, and solemnly informed them that they were ' The Shropshire Orthopaedic Training School for Cripples.' They were suitably impressed but were anxious to know what happened next. As this was more than I could tell them the meeting adjourned." Miss Hunt decided to write to the County Councils and Poor Law Guardians and " offer this splendid opportunity of making their cripples self-

supporting." The replies flabbergasted her. "Before you could say 'knife' we had one hundred and fifty names on the waiting list and not even a hut to put them in. Where were they to be housed and fed? What trades would be suitable? What about instruction? How would the hospital committee take this new venture? And where on earth would the money come from?" As usual, enthusiasm came first; but accomplishment came next. With Miss Sankey, who is well remembered as a superb After-care Superintendent, Miss Hunt moved into the Derwen which was to become the Cripples' Training College. There was an early stage when after being granted £50 by the Committee "we also annexed some unconsidered trifles from the hospital." In the next stage Miss Hunt tried to work out the cost of surgical boots and wrote: "Ten shillings for leather and two days of man's time at three pounds ten shillings a week plus 5 per cent. profit equals —? Eventually I put x which I had been told meant an unknown quantity, and went dismally to bed." Mathematics and financial acumen were not her strong points but, within a year, Mr Rhaiadr Jones and his wife were appointed Manager and Matron, and thereby the Cripples' Training School gained the services of a first-class financier and a devoted woman who have applied themselves to this task ever since. A college was established for the training of crippled children, of whom no less than 90 per cent. have made their own livings.

Twenty years later the Disabled Persons' Employment Act was passed by the Government of this country, and the Disabled Persons' Corporation was established. Of the one million disabled who are now registered in Great Britain a high proportion have been trained to take their place in the open labour market and proved themselves to be no less efficient than their able-bodied colleagues. Those few whose disabilities were so grave that they could not have been expected to compete in the open market have been engaged in the sheltered factories of the Disabled Persons' Corporation, the trade name of which is "Remploy." At the same time voluntary effort has continued at the St Loyes' College for Training and Rehabilitation of the Disabled, Exeter; the Queen Elizabeth's Training College for the Disabled, Leatherhead; the Heritage Crafts' School, Chailey; the Lord Roberts' Memorial Workshops; the John Groome's Cripplage; the Robert Jones' Workshops; the Papworth and Enham Village Settlements; the St Dunstan's Institutes for the Blind; the National Institute for the Deaf; and the Duchess of Portland's Training College for the Disabled, Nottingham. Little did those four boys and two girls realise, when they were appointed solemnly as a Training School for Cripples, that they were to be forerunners of a great reform in resettlement of the disabled of which Great Britain is now proud.

Agnes Hunt, the "Florence Nightingale of orthopaedic nursing," who received the Royal Red Cross in 1918, and was created a Dame of the British Empire in 1926—the highest honour which can be awarded to any woman in this country—was responsible for important advances in preventive treatment, the creation of an orthopaedic hospital, the organisation of an after-care system, and the development of a Cripples' Training College. In recent years she asked herself to name the essential qualities of a nurse and replied: "Common sense, gentleness, kindliness, and the power of giving hope and joy to those who are suffering." In these words she linked herself with those who are ageless, for was it not Galen who wrote: "Confidence and hope do more good than physic. He cures most in whom most are confident"? Most were confident in Agnes Hunt. At the early age of eleven she learned to enjoy life despite disability; at the age of eighty-one she died as she had always been—cheerful, brave, courageous, indomitable. She proved by example rather than by precept, and the decision of history may well be that the greatest of all her contributions was her own life.

REGINALD WATSON-JONES

The quotations in this appreciation are from "This is my Life" by Agnes Hunt (Blackie & Sons, Ltd., London, 1938) and "The Story of Baschurch" (Caxton Press, Oswestry). I am also grateful to Mr Rhaiadr Jones for access to many unpublished documents. The colour print of Dame Agnes Hunt has been reproduced by kind permission of the Derwen Cripples' Training College, Oswestry.

THE ART OF OSTEOGRAPHY

WILLIAM BROCKBANK and D. LL. GRIFFITHS, MANCHESTER, ENGLAND

From the Medical Library of the University of Manchester

The early development of orthopaedic surgery and of the science of human anatomy ran hand-in-hand. Anatomists were surgeons. The surgery of the body-cavities was impossible; so that one may claim fairly that anatomists founded their science as part of the development of limb surgery and the surgery of the body wall, though, naturally, their attention was also focused at an early stage on the anatomy of the viscera.

In days when dissections were rare, illustrations of anatomical detail were peculiarly important. Skeletons could be acquired only with much difficulty and with no little risk. Vesalius acquired one skeleton by removing a body from the gallows. The work of the artist was an important medium in the spread of anatomical knowledge. These early illustrations are of interest to-day. Many are of great artistic value, and it is interesting to note how many artists saw the skeleton as a living structure, to be depicted in attitudes of action. Certainly they did not regard the skeleton as a series of " dry bones " as have many of their successors.

Anatomical illustration came into its own in 1543 with the publication of *De Humani Corporis Fabrica* by Andreas Vesalius (1514–1564), a surgeon who at the age of twenty-three years became Professor of Surgery and of Anatomy at the University of Padua. The *Fabrica*, which first discarded the Galenical tradition by describing human and not animal anatomy, is one of the most important works in the history of medicine. It was illustrated by Titian's pupil, Jan Stephen Kalkar, the first artist to produce anatomical pictures which combined beauty with reasonable accuracy. Vesalius supervised his illustrator's work with great care and sometimes complained of the time and trouble which had been consumed. The pictures were made chiefly from dissections of strong and youthful bodies; they were printed from clear wood engravings (Fig. 5).

In 1685 Godfried Bidloo (1649–1713) of Amsterdam published his great *Anatomica Corporis Humani* with engravings from drawings made by Gerard de Lairesse. These are adorned with many accessories in design in the well-known style of Lairesse, but the figures show that the artist lacked expert guidance. This can be seen clearly in the skeleton shown in Fig. 6, which does not show natural proportions and is heavy and lacking in beauty. It is not known who made the engravings but they are most elegantly done. Bidloo worked on his book for nine years and on the strength of it was appointed to the Chair of Anatomy at Leyden in 1694. Later he became Court Physician to William III, and he accompanied that monarch to England.

These plates had an interesting history. In 1698 William Cowper (1666–1709) published in Oxford his *Anatomy of Human Bodies*, including in it one hundred and five of Bidloo's plates, so that his work was original only in the text which was admirable, and in nine other plates supplied by Cowper himself. Cowper's publishers had apparently bought three hundred copies of each plate from Bidloo's publishers without Bidloo's knowledge or consent. Although Cowper praised the artist in his introduction, his only reference to the man who made the dissections was to say that the plates " were sometime published by Dr Bidloo." Bidloo was annoyed and upbraided him in a publication *Gulielmus Cowper criminus literaris citatus* (1700). Nevertheless it cannot be denied that Cowper's was much the better book.

William Cheselden (1688–1752) was the outstanding surgeon of the first half of the eighteenth century. He was a popular figure, with a wide circle of distinguished friends. He enjoyed life. He was a keen follower of prize-fighting. He was a racy and a witty talker. But above all he was an amazingly skilful surgeon. He was one of the earliest surgeons to dissect publicly at his own house the bodies of criminals, and in so doing to earn the displeasure of the Barber Surgeons' Company, for his lectures coincided with theirs and were more popular. He became remarkably adept at the operation of lateral lithotomy, frequently performing it in one minute—his record being fifty-four seconds—a feat which was of great importance in days when there was no anaesthesia. His mortality of 17 per cent. was not unduly high.

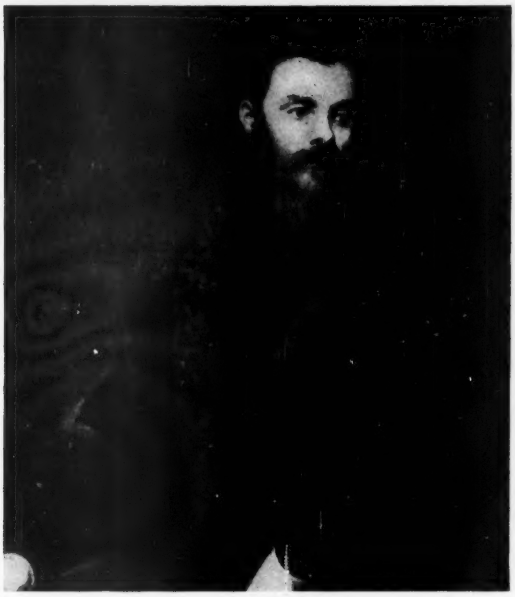


FIG. 1

Andreas Vesalius (Brussels, 1514–1564) from a painting by Tintoretto—from Wegner.

FIG. 2

Godfried Bidloo (Amsterdam, 1649–1713) from his Anatomica Corporis Humani.

FIG. 3

William Cheselden (London, 1688–1752) from Wegner.

FIG. 4

Bernard Siegfried Albinus (Leyden, 1697–1770) from Pettigrew.

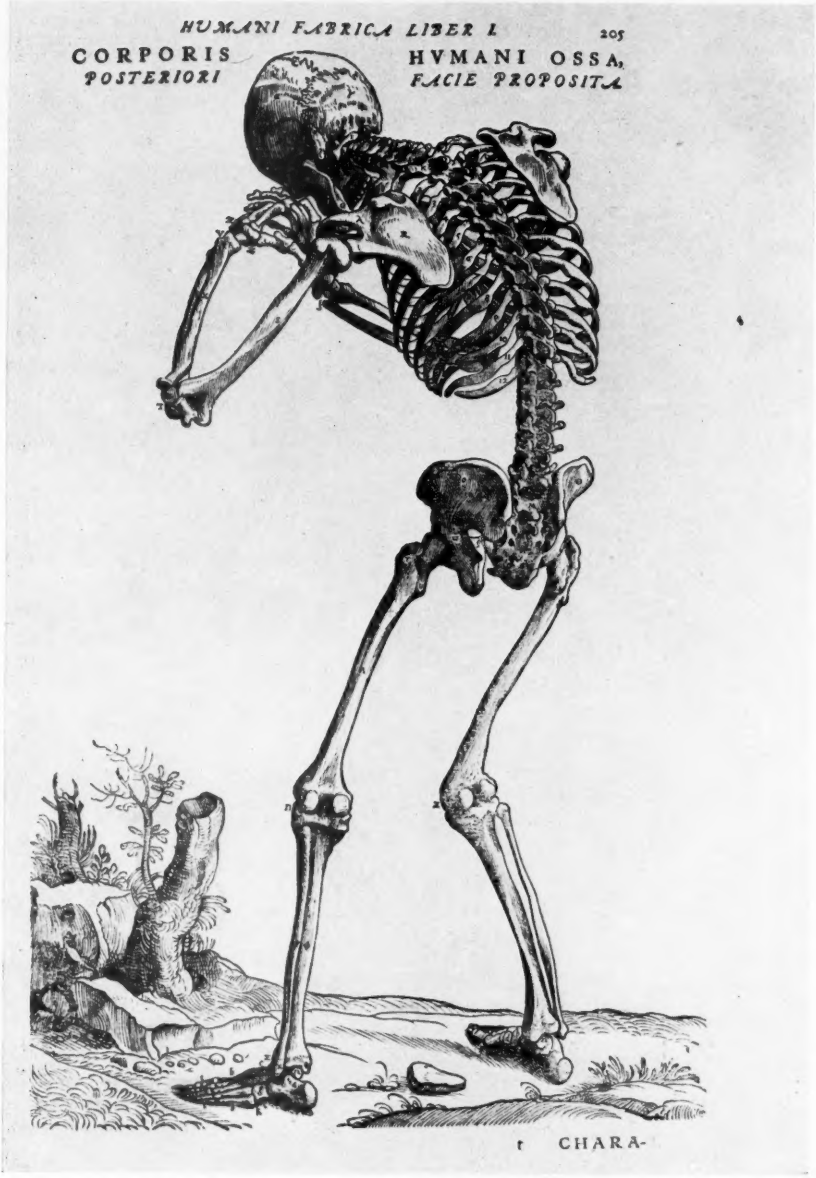


FIG. 5

From Vesalius: *De Humani Corporis Fabrica.*

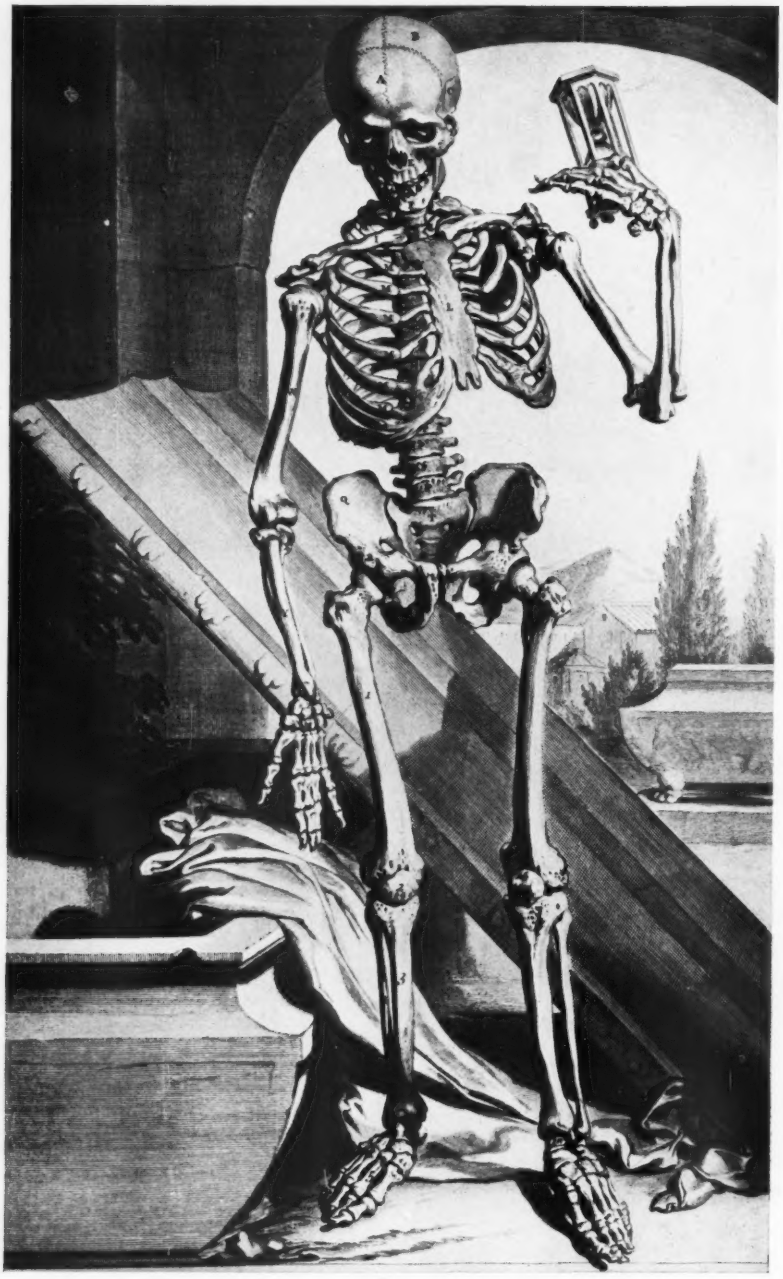


FIG. 6

From Bidloo: *Anatomica Corporis Humani.*

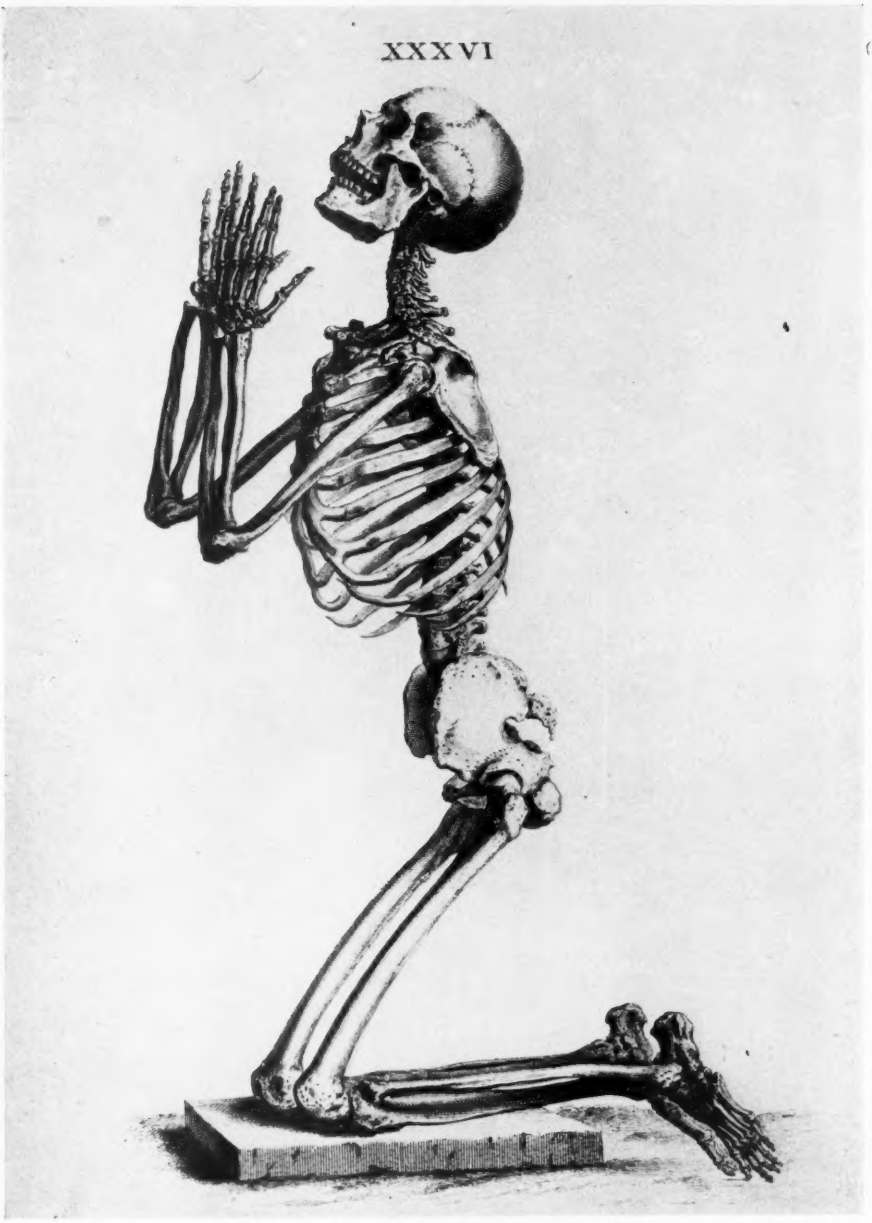


FIG. 7

From Cheselden: *Osteographia.*

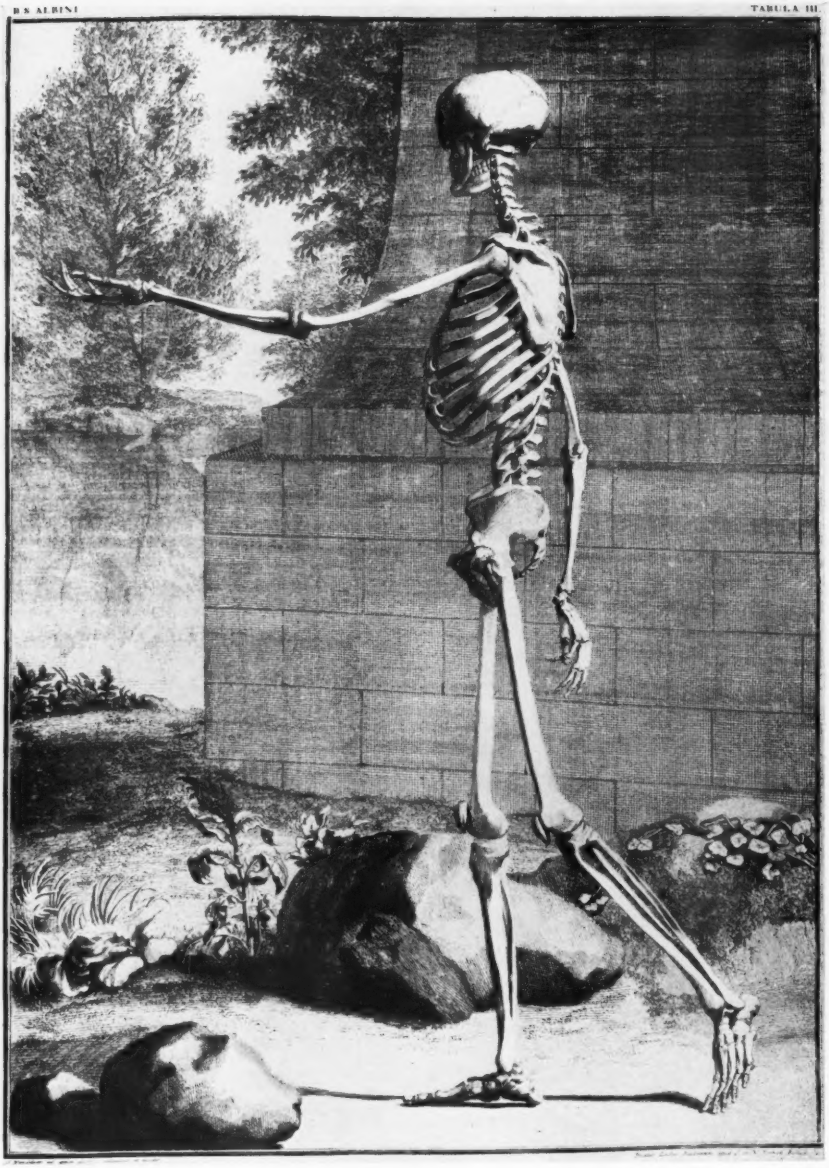


FIG. 8

From Albinus: *Tabulae Skeleti et Musculorum Corporis Humani.*

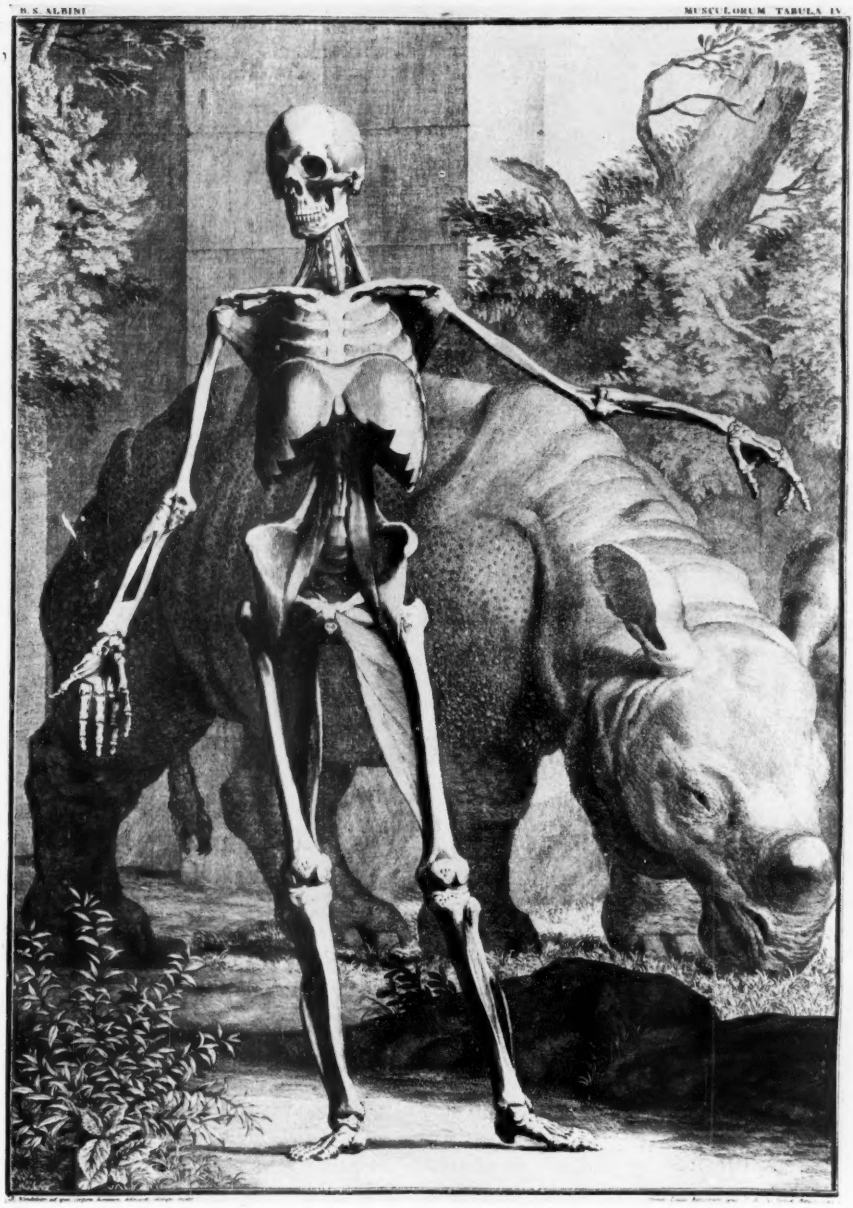


FIG. 9

From Albinus: *Tabulae Skeleti et Musculorum Corporis Humani.*

He wrote several books, the most interesting of which was his *Osteographia* published in 1733. It was dedicated to Queen Caroline and included full and accurate descriptions of human osteology with a fine series of fifty-six engravings, mostly of individual bones (Fig. 7). These were probably drawn with the camera obscura and the title page shows Cheselden making a drawing by this method. Not only does this book reveal the normal anatomy of bones; it shows something of bone disease, and is one of the finest of English works with anatomic illustrations. It also includes an engaging series of illustrations of the skeletons of animals, birds and fishes.

Bernard Siegfried Albinus (1697–1770) was the son of an eminent physician and professor of anatomy at the University of Leyden. He studied in that University and on the death of his father, in 1721, he was chosen to succeed him in the professorial chair, a post which he held for nearly fifty years. He was an incomparable lecturer but his claim to everlasting fame is that he published a number of anatomical atlases, some of which have never been surpassed in the beauty and accuracy of their illustration and the elegant style of the accompanying text. The most outstanding deals with the bones and muscles; it was published in 1747 with the title *Tabulae Skeleti et Musculorum Corporis Humani*. The drawings and engravings were made by Jan Wandelaar. In order to gain exact proportions, many anatomical drawings were made from actual bodies; they were measured carefully and were then averaged in order to gain the final result. For the drawing of skeletons ingenious contrivances were suggested by a professor of physics. Two nets, as large as the skeleton itself, were divided into squares. They were placed in front of the skeleton, one very close, and the other, with squares ten times as small, about four Rhenish feet away. The artist stood forty feet distant from the object, and by means of the two nets gained proper perspective. In order to depict more accurately such parts as could not be distinguished from a distance he could approach the first net closely and, by relating his drawing to the larger squares, could still record detail accurately in proportion to the whole. An account of the method may be read in the preface to the book. Curious and interesting are the accessories to the figures which were chosen, by which to give an impression of proportion (Figs. 8 and 9). They are thus in contrast to the figures in other anatomical works where accessories are quite unrelated to the subject in hand.

These anatomical atlases were vital necessities to students of anatomy and surgery whose chances of learning anatomy by dissection were few. Hoffman at Halle secured no more than twenty bodies for dissection in twenty-four years. In Prague there were only three dissections in the twenty years after 1692, and Albinus himself obtained only one body each year. Yet, after two hundred years the Albinus *Atlas* remains unsurpassed. Even to-day its pictures convey something of the enthusiasm of pioneer anatomist-surgeons who never lost sight of their interest in the anatomy of the living. Their successors, whose work has been so much concentrated on the formalin-hardened dead, have in this respect much to learn.

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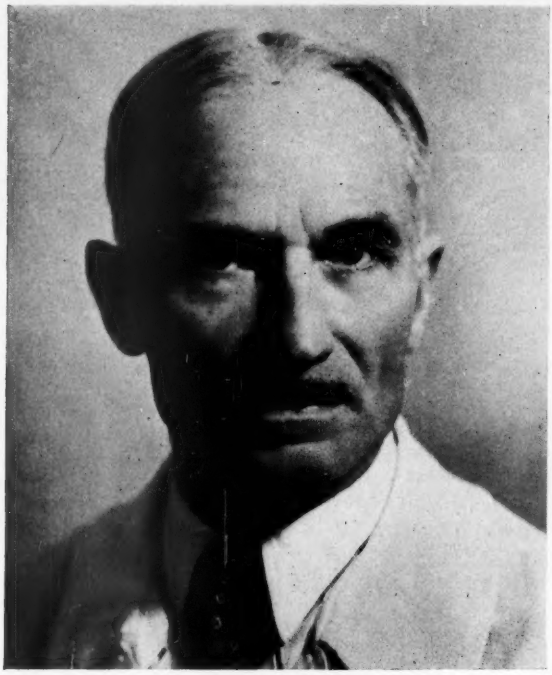

IN MEMORIAM

PROFESSOR JACQUES LEVEUF
1886-1948

By the death of Professor Jacques Leveuf at the height of his powers, French orthopaedic surgery has been deprived of an outstanding modern leader. Leveuf had many close ties with Great Britain. His dynamic personality had become one of the features of recent meetings of the British Orthopaedic Association of which he was elected an Honorary Member in 1945. After the liberation of France he was eager to establish contact with his British colleagues and to expound with characteristic vehemence and eloquence his views on congenital dislocation of the hip, on acute osteomyelitis, and on many other subjects in which he appeared always to challenge orthodox beliefs and practice. Leveuf was born in Limoges and studied in the School of Medicine in Paris. After the usual junior interne appointments he was for many years an assistant in the surgical clinic of Pierre Delbet. He worked with Delbet in the early attempts to nail fractures of the femoral neck under X-ray control. This experience no doubt largely determined his choice of the surgery of bones and joints as his life work. In due course he achieved the coveted status of " Surgeon to the Hospitals of Paris " and became surgeon-in-chief at the Bretonneau Hospital. In 1942, on the retirement of Professor Ombrédanne, Leveuf was chosen as his successor at the Enfants Malades and in the Chair of " Infantile and Orthopaedic Surgery "—the blue riband of Paris orthopaedics. In the new surgical clinic designed by Ombrédanne, Leveuf began to work with ever increasing intensity on the problem of the treatment of congenital dislocation of the hip by open reduction. Before the war he had carried out a survey of the late results of manipulative reduction in the province of Brittany, where the deformity was exceedingly common, and had been impressed by the high proportion of poor results. During the last two years he had established a centre in Brittany for the diagnosis and treatment of this deformity. Arthrography, a technique in which he was a master, was practised on the newly born, and

many interesting observations had already come to light. His aim was to recognise those dislocations in which an interposition of soft tissues existed which would prevent the concentric re-position of the femoral head into the depths of the socket. Once this anomaly had been demonstrated it was, in Leveuf's view, a waste of time attempting to treat a congenital dislocation by manipulation.

Leveuf attended the Annual Meeting of the British Orthopaedic Association in Manchester in October 1947, and appeared to be full of vigour. In the early part of 1948 he attended the meeting of the American Academy of Orthopaedic Surgery in Chicago. After his return from the United States it became evident that he was a tired man, and very soon there were unmistakable signs of the grave malady which brought his life to an end. Jacques Leveuf's death will be deplored throughout the world, not merely because of the many friendships which had made him an international figure, but because he had great contributions still to make to the art and science of orthopaedic surgery. H. P.

Professor Jacques Leveuf has been taken away suddenly at the age of sixty-three in the midst of a strenuous surgical and scientific life. Many cultural, literary and artistic interests showed the breadth of his intellect. Above all his character was notable for a swiftness of comprehension. His passion for surgery, and the flame of his enthusiasm, led him to express views with an ardour which won furious opposition, or enthusiastic support, but never indifference. With this impetuosity he nevertheless had the rare quality of being able to change his mind and modify his views quickly. This agility of mind, enthusiasm, and direct approach kept him surprisingly young.

He made of the Clinique des Enfants-Malades a complete service, directing a group of distinguished colleagues, and himself taking a leading part in the orthopaedic surgery of children in which he was so interested, in traumatology, neurosurgery, and plastic surgery. A member of the Academie de Chirurgie, the British Orthopaedic Association, and the American Academy of Orthopaedic Surgeons, he made his contribution with a fervour which commanded wide attention and interest not only in France but in the world. A great void is left in the surgery of France. R. M. D'A.

MISS EUGENIE LEESON WILLIS
1910-1948

A career of promise has been cut short by the death of Miss Willis after a long and disabling illness which she faced with characteristic courage. A graduate of Cambridge and of the London School of Medicine, Miss Willis was one of the few women members of the British Orthopaedic Association and one of the few women to obtain the Fellowship of the Royal College of Surgeons of England. After a period of junior resident appointments in her own teaching hospital she was appointed Resident Surgical Officer at the Oldham Royal Infirmary in 1940. In 1942 she was appointed to the Manchester Royal Infirmary as Chief Assistant in the Orthopaedic Department, a post in which she had to bear added responsibility in the treatment of many battle casualties coming to that hospital at a time when its surgical staff was greatly depleted by the calls of the Services. She also served the University of Manchester in the Departments of Orthopaedic Surgery and Anatomy. The long hours of labour and the rich experience which fell to her lot during those years should have been the prelude to a long and distinguished career as an orthopaedic surgeon, but before the end of the war the symptoms of the disease from which she died had already appeared. Despite a suspicion that her active life would be short, and despite the certainty which soon replaced that suspicion, Miss Willis continued her work in a manner which excited the admiration and respect of all her colleagues. She retained courage and good spirits to the end, and is sincerely mourned by patients and colleagues alike. D. Ll. G.

PROCEEDINGS AND REPORTS OF UNIVERSITIES, COLLEGES, COUNCILS AND ASSOCIATIONS

INTERNATIONAL SOCIETY OF ORTHOPAEDIC SURGERY AND TRAUMATOLOGY

The fourth congress of the International Society of Orthopaedic and Traumatic Surgery was held in the famous Indisch Instituut, Amsterdam, during the week September 13 to 18, 1948, under the patronage of Her Majesty Queen Wilhelmina. Two hundred delegates attended from twenty-seven countries. The congress owed much to the Dutch capacity for smooth organisation which was personified in the secretary, Dr J. D. Mulder. On several occasions the president of the congress, Dr Henry Meyerding, expressed his relief that more trouble had not arisen in the timing of sessions which on paper were filled, and indeed hopelessly overfilled, with vast numbers of contributions. One of three days of scientific proceedings was devoted to reports on closed fractures of the spine, another to arthritis deformans of the hip joint, and a third to a series of short papers.

Medal struck on the occasion of the Fourth Congress of the International Society of Orthopaedic Surgery and Traumatology, held in Amsterdam

The Institute had a large and a small lecture hall, and two licensed restaurants. Coffee was served continuously in the entrance hall where there was also an exhibition of instruments and books. These diversions were in great demand, for many contributions were delivered in languages with which few were familiar. In the scientific exhibit, attention was attracted by many excellent instruments for osteosynthesis which included bone clamps based on the designs of Professor Lambotte who now lives quietly in a suburb of Antwerp, and pursues his hobby of making violins and 'cellos with superb craftsmanship. The circular saw, designed in Great Britain by Messrs Desoutter Bros., had been modified by a Belgian firm in such a way as to act in a longitudinal axis, and the intermittent whine of this instrument was the basic musical note of the congress; it served as a descant to every conversation. Apart from daily scientific sessions at the Institute, two very enjoyable evening receptions were held in the Rijksmuseum and the Stedelijk Museum. The galleries were thrown open to members and guests. The Rijksmuseum included not only its own treasures but also the touring Munich collection, and the Stedelijk Museum once again housed its famous collection of Van Goghs, so that the receptions were of particular interest.

At the general meeting there was comment and discussion on difficulties which had arisen from the language problem; it was urged by some that contributions should be delivered in French or English, and that lantern slides should include legends in several languages. There was also debate on the constitution of the Society and the method by which members and delegates were elected. It was decided that the next Congress should be held in Stockholm in 1951, and that Professor Richard Scherb of Zurich should be president. The main subjects selected for discussion were " Bone Changes in Avitaminosis " and " Low Back Pain." Sir Harry Platt (Great Britain) was elected president of the Society, and Professor E. Sorrel (France) and Dr San Ricart (Spain), vice-presidents.

Closed Fractures of the Spine—The discussion was opened by *E. A. Nicoll* (Great Britain) whose findings were based on a long-term review of dorso-lumbar fractures in miners. He classified these injuries with special reference to lateral wedge fractures and isolated fractures of the neural arch. Lateral wedge fractures had anatomical and clinical characteristics which differentiated them from anterior wedge fractures. Isolated fractures of the neural arch were sub-divided into those above the fourth lumbar

vertebra which had little or no tendency to forward displacement, and those at the fourth-fifth lumbar levels which if untreated caused progressive spondylolisthesis. Early recognition was essential, and if displacement had already occurred open reduction and grafting was advocated.

In a study of the relationship between long-term anatomical and functional results no support was found for the assumption, on which orthodox treatment had been based for many years, that perfect anatomical position was indispensable to perfect function and was the essential objective in treatment. This was illustrated by individual case records and statistical analysis. Redisplacement after closed reduction and prolonged immobilisation was common; it was due to comminution of the vertebral body, crushing of the intervertebral disc, or rupture of the interspinous ligament, all of which could and should be recognised at the outset.

The important factor in determining function was stability between the injured segments, and not the position in which stability was achieved. For the purposes of treatment, cases were divided into stable and unstable types. Stable types included anterior and lateral wedge fractures, and fractures of the neural arch above the fourth lumbar level. Unstable types included fracture-dislocations, and fractures of the neural arch at or below the fourth lumbar level. Stable fractures were treated after a short period of rest in bed as soft tissue injuries. Unstable fractures were treated by protective plaster in a position permitting anterior stabilisation, or by open reduction and grafting. When there was paraplegia, immediate open reduction and grafting was recommended in order to restore the lumen of the neural canal and produce a stable spine at the earliest possible moment, thus permitting early ambulation and avoiding urinary complications. In such operations it was essential to avoid plaster fixation which almost invariably caused pressure sores. The graft must be self-stabilising, and one such type of graft was demonstrated. It was urged that more regard should be given to soft tissues; it had been proved that prolonged immobilisation of damaged soft tissues in a shortened position caused disabling symptoms. *Lorenz Böhler* (Austria) said that the three essential principles of treatment were: complete reduction; absolute immobilisation; and exercises during and after the period of fixation. It was possible to secure complete reduction only during the first two weeks. The ideal time for reduction was the day after injury when two-thirds of spinal fractures could be reduced by the closed methods of Davis or Watson-Jones; the other third could be reduced in the supine position. Exercises in plaster were illustrated by a film. Even after four months' immobilisation, patients could bend forward and touch their toes immediately the plaster was removed. If correction of deformity could not be achieved, fixation in plaster was not indicated; exercises were then started after two weeks. Fractures of the upper dorsal spine could be reduced only during the first week and only in patients under thirty years of age. A plaster cast was applied to the trunk which was hyperextended in the supine position; the patient was then sat up and a Glisson sling used while the neck and head were incorporated in plaster. The cervical spine was not hyperextended and the chin was left free. Fractures of spinous and transverse processes were treated as soft tissue injuries by immediate active exercises. Fractures and dislocations of the cervical spine were reduced by skull traction, and a plaster cast was applied without hyperextending the neck. When there was clinical evidence of complete paraplegia, death was usual within forty-eight hours. Reduction of fractures complicated by damage to the spinal cord was useless at any level if there was complete motor and sensory loss—no attempt at reduction should be made; but if clinical signs pointed to an incomplete lesion of the cord, reduction of the fracture and immobilisation in plaster for five or six months was indicated. This was combined with skeletal traction to both legs through the tibial tuberosities.

Operative Treatment of Closed Injuries of the Spine—*Carlo Pais* (Italy) reported six hundred cases treated at the Rizzoli Institute. Operative treatment was never undertaken until the third or fourth week after injury. There were three main indications: to secure reduction where conservative efforts had failed; to maintain reduction in unstable cases; and to decompress a damaged cord. The usual cause of failure of closed reduction was locking of articular facets; but grafting was seldom used in these cases after open reduction. Spinal fusion was indicated as a delayed operation when there was persistent pain due to deformity, non-union, secondary arthritis, or spondylolisthesis. When there was involvement of the cord with evidence of bone pressure, decompression laminectomy was performed after three weeks. Queckenstedt's test was essential and myelography was often used. It was unnecessary to open the dura. A film illustrating the technique of decompression laminectomy gave a beautiful demonstration of the fact that disc material or bone fragments were often pressed back on the anterior aspect of the cord during attempted closed reduction. The posterior arches were excised, the dura retracted, and projecting pieces of bone or disc material removed from the anterior aspect of the cord. Decompression laminectomy was also carried out at later stages if spinal block could be demonstrated and the patient was not making good progress. In late laminectomies it was essential to open the dura because arachnoid adhesions were common and should be freed. The results in late cases were, however, disappointing. Operative treatment was also indicated in painful and spastic conditions resulting from paraplegia. When spasticity was predominant, postero-lateral cordotomy was indicated; but when pain was the chief symptom antero-lateral cordotomy should be performed.

Paraplegia due to Vertebral Fractures—*Henry Meyerding* (United States of America) dealt with the rehabilitation of patients with vertebral column fractures complicated by spinal cord injury. When the cord was transected, surgical and nursing problems were serious and complex. The economic and social problems of cases which were not rehabilitated taxed the resources of both family and community. Care should be taken in early stages to avoid pressure sores by frequent change of position, to prevent contractures by daily passive movement, and to arrest urinary infection by chemotherapy and early mobilisation. Resisted exercises for the development of muscles used in crutch walking were started in bed at the earliest possible moment. Abdominal and spinal muscles concerned in maintenance of the upright posture were also developed. Exercises were then carried out on a mat, and between parallel bars in which the patient acquired a sense of balance and learned to support weight on his arms. In the final stages various crutch gaits were taught; they were based on the classical work of Deaver of New York. Patients must be able to get up and down stairs, and to cross a wide road between changes of traffic lights. Another method of progression which relied on the sitting position with sawn-off tripod crutches was of particular interest to this writer, a few days later, when he saw an exactly similar method depicted in a sixteenth century painting in the Rijksmuseum. All patients were provided with folding wheelchairs. Vocational instruction was given so that they might become economically independent. Training and resettlement called for the co-operation of many services. It was essential that the team of specialists in orthopaedics, physical medicine, urology, and psychiatry, should be endowed with optimism and with enthusiasm which communicated itself to the patient and prevented him from becoming a dependent invalid. These facilities could be provided only in highly specialised institutions and segregation in special centres was urged. The expense of making these patients independent was less than the cost of maintaining them as permanent invalids.

A. Bonola (Italy) demonstrated the suspension apparatus used for re-education of paraplegics at the Rizzoli Institute, Bologna. The patient was suspended by a harness fixed to a track in the ceiling. Bivalved plaster leg splints were worn, and in the later stages braces with locked knees. The patients used a walking machine in which leg movements were activated by hand controls.

P. Magnuson (United States of America) said that in the United States Department of Veterans' Affairs the treatment of traumatic paraplegia had been segregated in eight centres. Two thousand cases were constantly under treatment and now that civilian cases were being admitted the number was increasing. It was essentially a team job. In primary treatment the orthopaedic surgeon and neurosurgeon played an important part. Early laminectomy with fusion gave the best results; there were less trophic complications and there was less pain. Early walking exercises in suspension apparatus restored a sense of balance and helped to avoid urinary complications. Psychological problems were important. One of the best stimulants in the United States of America was a lovely girl, paraplegic at the eighth dorsal level, who herself had achieved a remarkable degree of rehabilitation and toured their centres regularly. It was perhaps unfortunate that, in the United States, pensions for paraplegia due to Service injuries guaranteed financial security to such an extent as to reduce the incentive of the patient.

P. Lewin (United States of America) stressed the value of Stryker frames in avoiding pressure sores. The oscillating bed improved nitrogen balance and prevented stone formation. Fascial transplants in patients with paralysis of the abdominal wall were valuable.

Sequelae of Vertebral Fractures—*San Ricart* (Spain) discussed the sequelae: pain, deformity, stiffness, and paralysis. Treatment was discussed under three headings: mobilisation; fixation; and neurosurgical operations. Treatment by mobilisation included various forms of heat to soften scar tissue and aid resolution of fibrosis; it was useful in fractures of transverse and spinous processes and in the treatment of secondary curvatures due to muscle contracture. Treatment by fixation included temporary support by plaster casts and leather corsets, and permanent fusion by spinal operation which was indicated in Kummel's disease and traumatic spondylolisthesis where mobility was limited and painful. When spinal fusion was under consideration, temporary fixation in plaster should first be used as a therapeutic test. Flexible types of osteoperiosteal graft were preferred; the patients were nursed on a firm mattress without plaster fixation for a period of four to six months. Neurosurgical procedures included novocain injection and surgical interruption of the pathways of pain. When there was disc prolapse, two or three complete arches should be resected in order to gain adequate exposure. If lipiodol had been used the dura should be opened so that the oil could be extracted completely.

Second thoughts on the Discussion on Spinal Fractures—*Alberto Inclán* (Cuba) and many other speakers contributed to this discussion. In retrospect, the lasting impression which remains is that of wide differences of opinion which still exist even on fundamental principles of treatment. For example—the objective must be anatomical perfection; the objective must be stability, which is often incompatible with anatomical perfection: again—in the management of paraplegia open reduction must be immediate; operation must never be undertaken in the first four weeks: once more—the fracture should be ignored; the fracture should be immobilised in hyperextension; the fracture should be immobilised in the neutral

position: and so on. An intelligent visitor who had never read a text-book of orthopaedic surgery might reasonably be excused for confusion, and for wonder that nine-tenths of a surgical discussion should be devoted to the technique of achieving half a dozen different objectives, and only one-tenth to discovering the right objective to pursue.

Treatment of Osteoarthritis of the Hip Joint—*P. Mathieu and P. Padovani* (France) reviewed developments of arthroplasty by the interposition of fascia, acrylic resins, and vitallium cups. Such technique preserved length of the femoral neck and usually made it unnecessary to displace the greater trochanter downwards. Massive prostheses of the femoral head made from fine acrylic substances and fixed to the stump of the femoral neck by an axial shaft had been used recently in France. The bifurcation operation of Lorenz, and other types of osteotomy, had not justified earlier hopes. The results of drilling the femoral neck, and of joint neurectomy, were very inconstant. Arthrodesis of the hip with a three-flanged nail or bone graft was the best palliative operation.

J. Zahradníček (Czechoslovakia) discussed various forms of conservative treatment. He said that it was unwise to induce hyperaemia of the joint; treatment by radiant heat and diathermy was a failure; on the contrary blood supply should be reduced by rest and cold compresses. The merits of deep X-ray therapy had been over-estimated. " Tissue therapy," with transplantation of a piece of fresh, refrigerated placenta under the skin of the abdomen had led to improved function of the joint, relief of pain, and " refreshing of the whole organism."

E. La Chapelle (Netherlands) said that in preference to arthrodesis of the joint he performed shelf operations, arthroplasty with vitallium cup, joint resection and reconstruction, osteotomy, or decapsulation. The results of denervation operations were uncertain. For the drilling operation " there could hardly be found an indication."

J. Delchef (Belgium) said that although arthrodesis of the hip joint was no more than palliative, it relieved pain with certainty and gave the patient almost perfect function. His practice was to embed a bone graft in an intra-articular trough without completely denuding the joint surfaces, thus shortening the time of operation and reducing shock. The limb was immobilised in a full plaster spica for three months, and a short spica for another three months. The disadvantage was the tendency to stiffness of the knee joint.

G. Wiberg (Sweden) advocated arthrodesis of the hip joint with nail fixation as originally recommended by Watson-Jones, the operation being done in one or in two stages. Fixation by means of a nail alone should not be used unless the joint was already almost ankylosed by the disease. A serious disadvantage of fixation by nail alone was that deformity could not be corrected fully. The use of a tri-flanged nail in supplementing routine arthrodesis of the joint, which included complete denudation of articular surfaces, was a most valuable contribution.

M. N. Smith-Petersen (United States of America) reviewed the history of development of arthroplasty of the hip joint. He described his approach and the technique of reconstructing joint surfaces. The importance of post-operative care was illustrated by lantern slides and a film. It was emphasized that although mould-arthroplasty had been performed on a fairly extensive scale for many years, the results after ten years were not to be regarded as " end-results."

Fractures in Paget's Disease—*O. Stracker* (Austria) said that union occurred rapidly in the fractures of Paget's disease. He treated severe bowing of the femur or tibia by cuneiform osteotomy and plating.

Ewing's Sarcoma—*J. Valls* (Argentine) discussed the differential diagnosis between Ewing's sarcoma and reticulo-sarcoma of Huesco; they were liable to be confused on radiographic examination but there were marked histological differences. The prognosis was different. One patient with a reticulo-sarcoma of Huesco was alive and well eight years after being treated by deep X-ray therapy.

Cancellous Chip Grafting after Internal Fixation of Fractures—*J. Thomson* (United States of America) urged that internal fixation of fractures should be supplemented by grafting cancellous bone chips from the ilium. Statistics from two groups of cases, one treated by internal fixation alone, and the other by internal fixation with cancellous chips, showed marked increase in the rate of union in the latter group of fifty-two cases, thirty of which had been open fractures. In established non-union, an intra-medullary nail supplemented by cancellous chips had given good results.

Paralytic Scoliosis in Children—*A. Gruca* (Poland) said that extra-articular grafts failed to increase in length during growth of the patient so that they could be used to secure gradual correction of the deformity. He used a rib graft on the convex side of the primary curve. The fourth or fifth rib was dissected free, and after division of the rib beyond the transverse process it was swung down and fused at its lower end to a lumbar transverse process. At the same time a tibial strut was placed between a lumbar transverse process and the crest of the ilium on the concave side of the secondary curve; but in order that this graft might increase in length epiphyseal cartilage was included in it.

Tendon Transplantation for Radial Nerve Paralysis—*Merle D'Aubigné* (France) showed a film. The palmaris longus was transplanted into the extensor pollicis longus and brevis, the flexor carpi ulnaris into the extensor communis, and the pronator radii teres into the radial extensors of the wrist. A good end-result was demonstrated.

Volkmann's Ischaemic Contracture—*O. Scaglietti* (Italy) described a radical operation, illustrated by an excellent film, the whole flexor group of muscles being dissected with nerve and blood supply intact from the lower end of the humerus and from the origins in the forearm. The operation had been performed four times in children. The results appeared to be an improvement on those of the more conservative types of muscle slide which are usually practised, but the operation had been done at so early a stage that some were in doubt as to whether simple conservative treatment might not have succeeded.

Ununited Fractures of the Scaphoid—*Paul B. Steele* (United States of America) said that formal arthrodesis of the wrist joint was a difficult operation requiring skill and experience, and that it was unnecessary in uncomplicated non-union of fractures of the scaphoid. The operation he advocated was simple: a disc of osteoperiosteal bone, including the ununited fracture and part of the semilunar and capitate bones, was trephined from the back of the carpus and rotated through 180 degrees, thereby securing localised fusion of the carpus without interfering with mobility of the wrist joint or the carpo-metacarpal joints.

Traumatic Dislocation of the Hip Joint—*Lorenz Böhler* (Austria) discussed the treatment of traumatic dislocation of the hip joint in relation to avascular necrosis. A series of forty-eight cases was reported, none with fracture of the rim of the acetabulum, which had been treated by early mobilisation and weight-bearing. After reduction, and support in a splint for seven days, the patient began free exercises in bed; in three weeks he was allowed weight-bearing; in three months he was back at full work. It was claimed with pride that there had been only one case of aseptic necrosis. Some think that the inference is not at all obvious; they would prefer to await the results of follow-up.

Congenital Aplasia of the Femur—*C. Van Nes* (Netherlands) said that in most cases the ankle joint was at approximately the same level as the normal knee joint and if it could be turned round through 180 degrees it could be used as a knee joint in a prosthesis. A case was demonstrated in which there was also pseudarthrosis of the upper femoral shaft. This was fused and at the same time rotation osteotomy was performed. At a second operation the knee joint was fused and in due course a modified below-knee prosthesis was fitted. The patient demonstrated remarkably good function and satisfactory control of the knee mechanism of the prosthesis. Four cases had been dealt with and all were satisfactory.

Opaque Arthrography of the Knee Joint—*N. L. Capener* (Great Britain) said that arthrography was useful not only in the study of congenital dislocation of the hip joint but also in pathological disturbances of other joints. Radiographs were shown in which 35 per cent. diodone had been used—an innocuous material which was absorbed rapidly. Forty-six knee joints had been investigated without ill effect; indeed some patients with osteoarthritis claimed to have gained benefit. Torn cartilages could be demonstrated but clinical tests were more important.

Recurrent Dislocation of the Patella—*B. Boitcher* (Bulgaria) demonstrated an operation in which the medial half of the ligamentum patellae was transposed to a more medial attachment on the tibia, and the vastus lateralis was then freed from the patella, and a musculo-aponeurotic flap from the medial part of vastus medialis was brought under, and through, the lateral muscle near its attachment to the patella and sutured to bone. Thus, when the quadriceps contracted, the transposed muscle exerted a medial pull on the patella.

Tarsal Fusion for Tuberculosis—*J. Samson* (Canada) described arthrodesis for tuberculous disease of the tarsus by an inlay graft cut from the ilium and countersunk into the required area.

Equalisation of Leg Length—*J. Verbrugge* (Belgium) advocated shortening the normal leg at the sub-trochanteric level instead of in the middle of the femoral shaft where approach was more difficult and union less certain and less rapid. Apposition and alignment could be maintained easily by means of a long screw.

New Power-driven Saw for Femoral Osteotomy—*A. Campiglio* (Italy) recalled Professor Putti's dictum that the correct instrument for cutting bone was a saw and not a chisel. A saw had been devised which revolved in the same plane as the cylindrical handle on which it was mounted. The position of a drill hole in the bone, at the level and in the direction required, was confirmed by radiographic examination. Special bone levers with wide flanges protected the soft tissues. The blunt guide on which the saw blade was mounted was then introduced along the drill-hole and the bone was divided.

Küntscher Nail in the Treatment of Fractures of the Femur—*L. Böhler* (Austria) said that the Küntscher nail should be used only for fractures of the upper femoral shaft. An assistant maintained radiographic control of the position of fragments by means of a long periscope, with a mirror at an angle of 45 degrees, thus avoiding the effects of direct radiation.

The Anna Clinic, Leyden—The last two days of the conference were devoted to clinical meetings. This writer visited the Anna Clinic which is famous for the work of Murk-Jansen and is now under the direction of Dr Van Nes. A large portrait of Sir Robert Jones stands in the entrance hall and his signature occupies a place of honour in the visiting book. Dr Van Nes gave a remarkable demonstration of major surgery on two successive mornings. In the course of four and a half hours' operating he performed two cup arthroplasties of the hip, two arthrodeses of the hip, one shortening of the femur with plating and grafting, one spinal fusion with graft, and two capsulectomies of the hip joint. The pace of work was quite

remarkable. It was made possible by abandoning the changing of gloves and gown between operations and by using a trained staff to apply all plasters. Throughout the time that he was at work, Dr Van Nes explained his technique in four languages. One feature of his surgery of the hip joint was the medial approach. He seldom reflects the gluteal muscles. On the other hand he lifts the iliacus off the inner wall of the pelvis and holds it retracted by a Steinmann pin hammered into the bone, thus giving wide and free exposure of the hip joint and making it possible, for example, to insert sharp stainless steel nails from the pelvic aspect of the acetabulum in arthrodesis of the joint. In arthroplasty of the hip the refashioning of acetabulum and femoral head was carried out with great rapidity and with little of the finesse which is claimed to be essential by Smith-Petersen. On the last day, we enjoyed a most impressive demonstration of after-results in a large number of patients who were displayed with speed and facility. The Anna Clinic works under remarkable pressure. Operation lists, comparable to the ones we saw, are completed on six days every week. The turn-over of major cases in no more than 130 beds is remarkable. Many are transferred to the convalescent home on the afternoon of operation.

AUSTRALIA

ANNUAL MEETING OF THE AUSTRALIAN ORTHOPAEDIC ASSOCIATION, 1948

The eighth annual meeting of the Australian Orthopaedic Association was held in Perth (Western Australia) from August 11 to 13, 1948, under the presidency of Mr John Hoets (Sydney). The attendance was good, although for many it involved a " round trip " of 6000 miles.

Primary Malignant Tumours of Bone—This paper by *Sir Harry Platt* (Manchester, England) was read in his absence. He classified 187 documented cases into: bone sarcoma; haemopoietic tumours in bone; and adamantinoma. Two groups might be distinguished: extraosseous tumours in which the main mass could be felt superficial to the affected bone; and intraosseous tumours which included myxo-chondroma, giant-cell tumour, and haemopoietic tumours. In reviewing five-year cures he affirmed that biopsy before amputation was both useful and safe. Pre-operative radiation was condemned as a waste of time. His series of 114 accessible tumours, treated by radical operation, included twenty-six five-year cures—nineteen of osteogenic sarcoma and seven of extra-periosteal sarcoma. He had done six hind-quarter amputations with only one death. He believed that the merit of surgical eradication of tumours was proved. Amputation remained the chief contribution of surgeons to lasting cure, but local resection might be possible in a few selected cases. *Dr J. Hoets* (Sydney) had also seen bad results from pre-operative radiation in osteogenic sarcoma and advised early amputation. *Mr E. F. West* (Adelaide) advocated biopsy in all cases.

Chondromalacia Patellae—*Mr N. S. Gunning* (Adelaide) reviewed the results of twenty-five cases of chondromalacia of the patella treated by operation. The cause remained obscure and might be the result of direct trauma or of chronic infection of the knee joint. The most frequent symptoms and signs were: swelling, subpatellar tenderness, inability to climb stairs, pain on moving the knee with pressure over the patella, and crepitus. When there was no generalised arthritis complete excision of the patella gave good results, but there was often post-operative tenderness over the lateral margin of the femoral condyle. He considered that chondromalacia patellae was a frequent cause of the advanced arthritis seen in later life. *Mr E. F. West* (Adelaide) ascribed the degenerative changes to continuous friction under tension. He had noted them in recurrent dislocation of the patella for which he advocated excision of the patella.

Late Results of Surgical Treatment of Tuberculosis of the Hip—*Miss Elizabeth McComas* (Melbourne) reviewed cases of tuberculosis of the hip joint treated at the Children's Hospital, Frankston, since 1930. Fifty-six patients were treated conservatively, with eight deaths; and thirty-two by operation, with four deaths. Arthrodesis was performed in twenty-three cases; sound ankylosis was achieved in sixteen. The failures were all operated on at a young age, the youngest being six years. The average duration of conservative treatment before operation was five years. *Mr J. Lahz* (Brisbane) had used both the Wilson and the Brittain type of arthrodesis, and he thought that weight-bearing with external fixation promoted growth of the graft. *Mr J. Jens* (Melbourne) considered that shortening was aggravated by fixation in plaster, and preferred to use traction. *Mr McKellar Hall* (Perth) stressed the mild nature of the disease in Western Australia where sinuses did not develop and the need for arthrodesis seldom arose.

Rôle of the Subscapularis Muscle in Stability of the Shoulder Joint—Magnuson Operation—*Mr John Jens* (Melbourne) said that much could be learnt as to the stabilising effect of shoulder girdle muscles by considering the disabilities of poliomyelitis in which the medial and lateral rotator muscles of the shoulder had been paralysed. The head of the humerus could be moved passively in and out of the glenoid cavity. He demonstrated anatomical variations in the joint which predisposed to dislocation. High insertion of the subscapularis tendon, with absence of fibres reinforcing the anterior capsule and extending down the shaft, weakened the musculo-tendinous cuff and had been found in two cases of recurrent dislocation recently operated upon. He described in detail reinsertion of the subscapularis tendon by the Magnuson technique which had the object of limiting lateral rotation by approximately 50 per cent.

To secure a buttress action across the front of the joint it was often necessary to lower the tendon insertion by half to three-quarters of an inch. It was important that spread of the muscle should be maintained, and in fixing the tendon to its new attachment he advocated the use of two or three staples. It was considered unnecessary to remove a bone block of the lesser tubercle as advocated by Magnuson and Stack. He believed with other writers that the important factor in preventing redislocation was the establishment of a sound elastic buttress in front of the joint together with limitation in the range of lateral rotation. Though his series of cases was limited he believed that the operation was no less effective than the more complicated Putti-Platt procedure.

Papers were also read on *De Quervain's Disease* by Mr B. T. Keon-Cohen and *Supracondylar Fractures of the Femur* by Mr A. V. Meehan. Two clinical sessions were held. It was decided that the National Health and Medical Research Council should be asked to finance or initiate research into the epidemiology of poliomyelitis. The officers elected included D. J. Glissan (Sydney), president; D. W. L. Parker (Hobart), B. T. Keon-Cohen (Melbourne), and N. S. Gunning (Rose Park, S. Australia), vice-presidents; A. R. Hamilton (Sydney), honorary secretary; G. K. Smith (Melbourne), honorary treasurer; W. L. Macdonald (Sydney), honorary editorial secretary; and A. C. Armstrong, H. C. Barry, R. J. B. McEwen, L. J. Woodland, members of committee.

AUSTRALIAN MEDICAL CONGRESS OF THE BRITISH MEDICAL ASSOCIATION SECTION OF ORTHOPAEDICS AND PHYSICAL MEDICINE

The Australian Medical Congress of the British Medical Association, 1948, took place in Perth (Western Australia). The orthopaedic and physical medicine sections met from August 17 to August 20 under the presidency of Mr C. W. B. Littlejohn, C.B.E.

Conservative Treatment of the Injured Back—*Mr Stuart Scougall* (Sydney) recalled that muscles and ligaments, as well as intervertebral discs, could be injured. Treatment was limited by ignorance of the physiology of posture. He discussed cortical analysis of pain, and the structures concerned in the " rest mechanism " as applied to the back. Defence against muscular fatigue were ligamentous locking, bilateral alternation, and the fascicular chain contraction of tonus. A fixed spinal list in low back lesions not only prevented this alternating rest mechanism and promoted fatigue and pain, but also overloaded muscles on the convex side, so that patients with loss of postural equilibrium due to a list should not be allowed about. The part played by muscle spasm in sciatic scoliosis, and the rationale of recumbency, traction, and plaster fixation was considered. Effleurage, sedation, or possibly local anaesthesia, aided the application of a jacket in normal posture. Fixation should be maintained for not less than six weeks if a disc lesion was suspected. The mechanics of lumbar movement were discussed and the importance of disc senescence in the production of prolapse was emphasized. Manipulation of the spine had no more than a minor rôle in treatment and, if disc protusion was suspected, only the relatively safe manoeuvre of rotation towards the affected side should be performed.

Indications for Operation on the Injured Back—*Mr E. F. West* (Adelaide) discriminated between: conditions requiring immediate operation such as locking of articular processes which might require facetectomy, or the rare instance of cord compression from acute retropulsion of an intervertebral disc or bone fragment; and conditions which might require late operation when symptoms arose some time after the injury. Compression fracture incompletely reduced was likely to produce localised spondylarthritis from malalignment of the posterior intervertebral articulations. In older patients conservative treatment with an efficient support should be tried first, but in younger individuals arthrodesis was preferred. Disc lesions in the lumbar spine demanded conservative treatment at first; recurrence called for exploration. In later life arthrogenic sciatica was common. Radiographs revealed pronounced thinning of the disc space and apophyseal arthritis. For this condition arthrodesis was advised. The sciatica of spondylolisthesis was usually arthrogenic and could be relieved by arthrodesis. Conservatism should be the rule in the treatment of low back disability and, in considering the indications for operation, due regard should be paid to the psychological background of the patient.

Treatment of the Injured Back by Physical Medicine—*Dr Frank May* (Melbourne) said that the commonest cause of low back disability was muscular or ligamentous strain. He discussed acute strain of muscles and fasciae, and methods of relief of pain by which to promote early active movement. Novocain injection was important in diagnosis as well as treatment. Early treatment prevented chronic traumatic fibrositis. Conditions predisposing to back-strain, namely faulty posture, obesity, spondylolisthesis, kyphosis and congenital anomalies, were reviewed. Methods of physical therapy were demonstrated.

Routine Treatment of Compound Fractures—*Mr John R. S. Lahz* (Brisbane) recalled that in 1865, Joseph Lister successfully treated a compound fracture of the tibia by the carbolic antiseptic technique. First-aid management and pre-operative preparation were discussed. Tourniquets, which caused tissue anoxia, were to be avoided. Liberal irrigation of the wound with a mild antiseptic solution such as 50 per cent. " Dettol," or 1/1000 " Monacain " under pressure, was advocated. Meticulous wound toilet was

imperative, without manipulation of the bone ends if this meant more than simple leverage of fragments which were seen and handled easily. Plating open fractures was ill-advised because it increased the risk of infection and reduced blood supply to the damaged bone. Fascia should not be sutured under tension. The skin should not be sutured if operation was performed more than eight hours after injury or if there was a gaping wound. Tight bandaging might cause slight and often unrecognised ischaemia.

Primary Internal Fixation of Fractures—*Mr B. Keon-Cohen* surveyed one hundred and eighty-seven closed fractures and forty-seven compound fractures treated by primary internal metallic fixation. The indications for internal fixation were: 1) to maintain reduction of unstable fractures; 2) to secure efficient immobilisation after complete reduction in those fractures which were slow to unite; and 3) to simplify the management of multiple fractures. Interposed soft tissue was an important cause of difficulty in reduction and delayed union, notably in spiral fractures of tibia, fractures of the medial malleolus, and many fractures of the humerus and femur. Intramedullary nails were valuable in fractures in the upper half of the femoral shaft. At operation a tourniquet was used whenever possible. Adequate exposure was secured by incisions so placed that plates and screws were neither subcutaneous nor crossed by the suture line. All operations were performed under penicillin control. Complete immobilisation of the wound was the most important single factor in promoting sound healing. All patients with tibial fractures, except those with bone loss, were allowed to walk in a caliper splint after three weeks. With a Küntscher nail in the upper third of the femur the patient took weight without support in three weeks, and with other femoral fractures after six to eight weeks. Movement of the shoulder, elbow, and forearm joints was begun after ten days with fractures of the humerus, and in four to six weeks with fractures of the forearm bones. Five instances of sepsis had occurred, all of which cleared up after removal of the metal. In the past eighteen months forty-seven compound fractures had been treated by primary internal fixation. Thirty-four healed by first intention and eight after minor degrees of superficial skin sloughing which did not affect progress. It seemed safer not to wait for the wound to heal, and for delayed union to become obvious, before carrying out internal fixation. Sixteen cases not included in the series had been treated by a combination of bone graft and some form of internal fixation; in six instances the wound broke down and infection caused delay in union. In deciding when to use internal fixation it was necessary to distinguish between "open" and infected fractures; many civilian fractures could be classed as open. The golden rules were: 1) meticulous wound toilet; 2) routine chemotherapy and maintenance of the haemoglobin level; 3) closure of the wound without tension, if necessary by skin grafting; 4) burial of metal under muscle; 5) absolute immobilisation of the limb until healing was complete.

The Traumatic Unit—*Mr C. W. B. Littlejohn* (Melbourne) in his presidential address opened a joint discussion with the Section of Surgery and described traumatic surgery as the grandparent of all surgery. The development of surgery and traumatic surgery, the growth of industry, the enormous increase in traffic accidents, and the lessons of two wars, had pushed this branch and its organisation to the forefront. In Great Britain much had been done, and traumatic units which were developed in war-time now dealt with civilian casualties with continuity of treatment from the time of injury to final rehabilitation and resettlement in industry. In his view it was better to develop traumatic units in association with general hospitals rather than to establish new hospitals devoted to trauma as had happened in Birmingham, England. Traumatic units should treat all fresh cases of bone injury, infections of the hand, and patients with residual deformity or interference with function by injury. It was unfortunate that insurance companies might not be interested in financing specialised traumatic units because they adjusted their premiums in accordance with liabilities.

Rôle of the Plastic Surgeon in a Traumatic Unit—*Mr B. K. Rank* (Melbourne) emphasizing the importance of primary skin healing in any case of open injury, considered that the part to be played by plastic surgeons was twofold: 1) the management of cases particularly appropriate to his practice including facio-maxillary injuries, many hand injuries, and all extensive soft tissue wounds including burns; 2) the treatment of many cases which hitherto had lain in "no man's land" and had often been handled indifferently in casualty departments. In compound fractures with skin loss local viability was the first consideration; it might be prejudiced by interruption of blood supply in raising a flap. There were two distinct principles underlying the design of local flaps—rotation and advancement; these were described with various applications. It was emphasized that plastic surgeons and orthopaedic surgeons should work side by side in traumatic units. In particular it was pleaded that the knowledge of plastic surgery now available should be utilised at an earlier stage.

Hand Injuries—*Mr B. K. Rank* (Melbourne) referred to the frequency in wounded men of stiffness of the small joints of the hand arising more often from inflammation, oedema, and immobilisation, than from actual tendon or joint damage. The difficulties of secondary repair emphasized the importance of initial treatment of the injured hand in a special unit. Of 4604 injured workers entering the Casualty Department of the Royal Melbourne Hospital during 1947, more than one-third presented hand injuries. The main object of primary treatment was complete soft tissue closure, no matter how severe the injury or tissue loss, and no matter what tedium there might be to the surgeon. Not unless the highest standards of

primary healing could be expected was immediate repair of tendon or nerve injuries justified. Hand injuries might be considered in two categories: "*Untidy*" *hand injuries*—In these, soft tissue wounds were often multiple, of an angular or jagged type, and with lacerated skin edges; there might or might not be skin loss. The primary aim was soft tissue closure with split skin grafts, transposed flaps, or primary direct flaps. In completing a traumatic amputation no more than was essential to effect closure should be removed because filleted soft tissue from redundant parts might be of inestimable value in secondary repair. "*Tidy*" *hand injuries*—This type of case, caused by choppers, knives, axes, and glass, called for primary repair of all injured structures, provided only that there was no real likelihood that infection was already established. In two years at the Royal Melbourne Hospital no case of tendon repair, primary or secondary, had shown infection. Mr Rank discussed the work of Bunnell in America and Pulvertaft in England, and emphasized that: *a*) tendon repair was futile unless joints were mobile, sensation adequate, and scars absent from the region; *b*) operation must leave two clean and uninjured tendon ends in accurate apposition; the finesse of atraumatic technique was more important than the particular suture material used; silk, nylon, or stainless steel wire were all effective; *c*) in order to meet the danger of reactionary swelling the thecal sheath should be excised completely except for a few stirrups in appropriately placed positions to prevent prolapse; *d*) posture of the hand after suture was important; *e*) movement should be limited for the first three weeks and then begin in the inner range. There was no longer reason for a fatalistic attitude in relation to severed flexor tendons. If joints were mobile, and sensation normal, a digit should not be amputated. It was urged that hand injuries should be segregated to the care of a few surgical teams in hospital. Only by long experience could a surgeon learn the pitfalls of hand surgery, and acquire the technique which would give a high percentage of good results.

GREAT BRITAIN

INSTITUTE OF ORTHOPAEDICS—POST-GRADUATE FEDERATION OF THE UNIVERSITY OF LONDON

The winter course of lectures and demonstrations in the Institute of Orthopaedics will be given at the Royal National Orthopaedic Hospital, Great Portland Street, and the country branch, Stanmore, beginning on Monday, October 4, and continuing until Saturday, March 19, 1949, under the leadership of the director, Mr H. J. Seddon, and the Dean, Mr H. Jackson Burrows. Each day there will be lectures in the basic sciences, clinico-pathological demonstrations, radiological and clinical conferences, demonstrations in the splint rooms and workshops, and academic lectures, in addition to the usual clinical practice of the hospital in wards, out-patient departments, and operating theatres.

BRITISH ASSOCIATION—110TH MEETING AT BRIGHTON, ENGLAND

The one hundred and tenth meeting of the British Association was held in Brighton from September 8 to 15, 1948. In his presidential address, Sir Henry Tizard discussed world food requirements. A discussion on human blood groups was held jointly by the sections of zoology, anthropology, and physiology. Professor Le Gros Clark (Oxford), discussing the findings of the British-Kenya expedition in their study of the fossil remains of early Miocene apes, said that the Miocene period was estimated to have lasted about twenty million years before the Pliocene period which itself lasted for possibly thirteen million years. Of particular interest were some Miocene limb bones—humerus, clavicle, femur, calcaneus, and talus—which had been discovered in this expedition for the first time. It was clear that these apes were not specialised for arboreal life but were capable of running, and leaping with agility, in marked contrast to the habits of modern anthropoid apes. The significance in relation to human evolution lay in the fact that hitherto many had argued that despite their apparent similarity limbs of human type could hardly have been derived from those which were characteristic of the modern anthropoid ape. To say the least, the foundation of such argument is now disturbed.

Sir Henry Dale introduced a discussion on transmission of effects from the endings of nerve fibres; and Professor F. R. Miller summarised the influences of eserine, actylcholine, and atropine on many varieties of synapses. There was much interest in Sir Ernest Rock Carling's discussion on the problems of old age, and the revolt which he claimed was justifiable against the "sixty to sixty-five years convention" of retirement.

INTERNATIONAL CONFERENCE ON SPEECH THERAPY

A conference on speech therapy, attended by delegates from the Dominions, the United States of America, six European countries, and two South American countries, was held in the Royal Society of Medicine, London, in September 1948. The problems of speech disorder were covered in a series of thirty papers, with detailed discussion on the dysphasia of Little's Disease, infantile paraplegia, and head injury, and the associated conditions of dysgraphia and dyslexia. It was a little disturbing to hear from

Dr Macdonald Critchley of the " normal verbal mannerisms " by which sentences are so often prefixed by such meaningless phrases as: " actually "; and " as a matter of fact." Dr Critchley said that as a rule women were more fluent than men, but men took more interest in speech for its own sake. They deliberated over *le mot juste* and they thought of the *double entendre* in a way that women did not. Those of us who use dictaphones and are astonished thereafter to hear what we have said, and those of us whose speeches are recorded verbatim and are astonished at what we read, may perhaps take solace in the fact that we are not alone in our " verbal mannerisms." The work of speech therapists has not yet been granted the recognition it deserves; but this conference demonstrated their pride in their work.

ANNUAL CONGRESS OF THE CHARTERED SOCIETY OF PHYSIOTHERAPY

The annual congress of this Society was held in London from September 22 to 26, 1948. After a reception at the Apothecaries' Hall the opening lecture was given by Sir William Scott Douglas on the " National Health Service." Mr P. Bauwens gave a paper on " Electromyography." Mr H. Osmond-Clarke discussed " Rehabilitation of the Injured." Suspension exercises were discussed by Mrs Guthrie-Smith. Mr I. S. Smillie gave a lecture on " The Quadriceps Muscle in relation to recovery from Knee Joint Injuries." The " Founder Lecture " was delivered under the chairmanship of Lord Horder by Professor L. J. Witts on " The Experimental Approach to Physiotherapy." A reception was held at the Guildhall by the Rt. Hon. the Lord Mayor of London.

INDIA

ASSOCIATION OF SURGEONS OF INDIA

The ninth annual conference of the Association of Surgeons of India was held at Bombay. Dr M. G. Kini of Madras (M.Ch.Orth. Liverpool, F.R.C.S. Edin.), was elected president. In his presidential address he discussed medical education and a suggested scheme for the reformation of Indian medicine, with observations on specialisation in surgery and training in operative technique. He discussed the rôle of pathologists in surgical teaching and made an appeal for the development of a post-graduate college.

BRAZIL

Unusual Disruption of the Pelvis—At the seventh Brazilian Convention of Traumatology and Orthopaedic Surgery an unusual disruption of the pelvis was reported by *Dr Eneas Balesdent and Dr Roberto Neves.* The patient, a man aged twenty-eight years, was thrown from his horse, sustaining a

Disruption of pelvis with overlapping of pubic bones reported by E. Balesdent and R. Neves (Brazil).

fractured clavicle, ruptured urethra, and complete dislocation of the ilium with sacro-iliac diastasis and overlapping of the pubic bones. The dislocation was reduced five hours later. The patient was placed on a wheeled stretcher with a sandbag under the sacrococcygeal region. The hips and knees were flexed and each lower limb was rotated outwards. At the same time two assistants, holding each ilium, moved them outwards and backwards by pressing on the anterior-superior spines. Complete reduction was accomplished at the second attempt. Three months later the patient was able to ride again.

EGYPT

EGYPTIAN ORTHOPAEDIC ASSOCIATION

An Egyptian Orthopaedic Association has been established under the first presidency of Professor M. Kamel Hussein (F.R.C.S. England, M.Ch.Orth. Liverpool, Professor of Orthopaedics in the University Farouk, Cairo). The executive committee includes Professor Gawad Hamada (M.B., Ch.B. Birmingham, Professor of Orthopaedics in the University Farouk, Alexandria); and Dr Aly Mohamed (M.Ch. Orth. Liverpool, surgeon at the Demerdache Hospital, Cairo). The founder members include: Dr A. M. Menaisy, F.R.C.S. England, and Dr A. H. Sharkawy, F.R.C.S. England, both of whom are assistant professors in the University of Cairo; Dr Mansour Shawky (Red Crescent Hospital, Cairo), Dr Philip Salub (Red Crescent Hospital, Cairo), Dr Rached Iskander (Public Health Hospital, Cairo), Dr Mohamed Mehrez (Demerdache Hospital, Cairo), Dr Aly Chahed (King's Hospital, Cairo), Dr Riad Wahbah (Ministry of Education, Cairo), Dr Edward Saddek (Director of Helouan Sanatorium, Cairo), Dr Abdon Sallam (Director of Marine Sanatorium, Alexandria), and Dr Ahmed Hamamsy (Egyptian Army Hospital, Cairo).

SPAIN

SOCIEDAD ESPANOLA DE CIRUGIA ORTOPEDICA Y TRAUMATOLOGIA

The annual meeting of the Spanish Association of Traumatic and Orthopaedic Surgery was held in Madrid on May 17 and 18, 1948, under the presidency of Dr M. Salaverri. Dr M. Salaverri (Bilbao) was elected president, Dr R. San Ricart (Barcelona) vice-president, Dr C. Gonzalez (Madrid) secretary, and Dr A. Garaizabel (Madrid) treasurer. Scientific and clinical contributions were read.

Treatment of Scoliosis—*Dr J. Troncoso* (Vigo) and *Dr San Ricart* (Barcelona) emphasized the importance of better understanding of the pathology of scoliosis in order that more logical treatment might be established. The etiology was often obscure, but in some cases light could be thrown on the problem by study of the history. Anatomical cure of established scoliosis was almost impossible, but in about 70 per cent. of idiopathic cases clinical cure could be achieved by conservative methods. In childhood, Steindler's conservative methods were found to be the most satisfactory, especially for idiopathic and rachitic scoliosis; in such patients treatment might be expected to give successful results in 100 per cent. of cases. Established scoliosis demanded treatment in specialised clinics under skilful direction. Spinal fusion, after maximal correction by the turnbuckle plaster jacket, was the best treatment. Gymnastic exercises and plaster jackets were valuable auxiliary methods but they could achieve little by themselves. Real advance would be achieved only when it became recognised that operation was imperative if conservative measures failed to arrest progress of the deformity. *Dr Fernandez Iruegas* (Madrid) agreed as to the efficiency of Risser's method when combined with spinal fusion. *Dr Salaverri* (Bilbao) advocated conservative methods of treatment.

Küntscher's Intramedullary Nail—*Dr F. Jimeno Vidal* (Barcelona) summarised the historical background of the technique of intramedullary nailing and the evolution of this method of treatment since it was first introduced in 1940.* The present situation in Germany made it difficult to study late results and it was therefore important to collect as much information as was possible from cases treated in Spain. He discussed the mechanical problems which arose, and the measures of technique which were demanded for their solution. He reviewed also biological aspects, especially alterations in bone physiology and the problems of bone infection. He disagreed with Küntscher's opinion that callus formation was stimulated by nailing. His experience with intramedullary nailing in the upper limb was disappointing. He believed that nailing should be limited to the treatment of oblique and transverse fractures of the middle and upper third of the shaft of the femur. In other regions the indications were few, and cases should be chosen with the utmost care. Intramedullary nailing was not indicated in children. *Dr F. Lopez de la Garma* (Madrid) reviewed his experience of intramedullary nailing of lower limb fractures. In fractures of the shaft of the femur the results were excellent in 94·1 per cent. of cases. In fractures of the shaft of the tibia there were 84·5 per cent. of good results. The time of bone healing was shorter than with other methods. Most patients could be allowed to resume weight-bearing at an early date. *Dr Garcia Diaz* (Oviedo) expressed optimism; he said that in all cases the fracture site should be exposed and the nail introduced under direct vision. *Dr Sierra Cano* (Santander) suggested that the nail should be used in treating pathological fractures; he showed several cases of fracture through the site of malignant bone tumours in which nailing had made the patient more comfortable, and had relieved him of pain during the period of his survival. After the discussion a commission was appointed to study all cases treated in Spain by the Küntscher method of intramedullary nailing. It was estimated that at least five hundred cases would be available for study.

* The fact is that it was introduced by Hey Groves, Bristol, England, before 1920—Editor.

Other Communications—*Dr Sanz Ibanez* (Madrid) reported the finding of poliomyelitic virus during the pre-paralytic period in the muscles of mice which had been inoculated experimentally. *Dr Salaverri* (Bilbao) presented seven cases of arthrogryphosis. *Dr Clavel* (Murcia) and *Dr Sanchis Olmos* (Madrid) showed two interesting cases of Leri's disease. *Dr Sanchis Olmos* showed good results from osteotomy of the femoral neck in the treatment of paralytic dislocation of the hip joint.

UNITED STATES OF AMERICA

William Darrach Memorial Lecture—The first William Darrach Memorial Lecture was given on June 12, 1948, at the Einhorn Auditorium of the Lenox Hill Hospital, New York, by Sir Reginald Watson-Jones (London) on the "Principles of Immobilisation and Mobilisation in the Treatment of Fractures." The lecture was given on the same day, and at the same hour, as a lecture which the late Dr William Darrach had planned to give as part of a course of instruction organised by the New York and Brooklyn Fracture Committee of the American College of Surgeons under the chairmanship of Dr Preston A. Wade, and contributed to by Dr Robert H. Kennedy, Dr Paul B. Magnuson, Dr Philip D. Wilson, and Sir Reginald Watson-Jones. Dr Preston Wade said: "It is with sincere regret that we record Dr Darrach's recent death. In his passing the medical profession has lost one of its greatest figures. We of the New York and Brooklyn Fracture Committee will miss him since he was one of the founders of this committee and one of its most staunch supporters." Sir Reginald Watson-Jones said: "Dr Darrach was more than a great surgeon. Even across the Atlantic we knew him as 'Uncle Bill.' He was a leader of men and made such an impression on his disciples and students that, through them, his work is perpetuated and multiplied so that it is in truth immortal."

Death and Growth of Bone—The Robert Jones Memorial Lecture at the Hospital for Joint Diseases, New York, was given on May 26, 1948, by Sir Reginald Watson-Jones (London) on the occasion of the annual Alumni Conference, under the chairmanship of Dr Leo Mayer. Sir Reginald said that the cause of death of bone, like that of any other tissue, was loss of blood supply. The blood supply might be destroyed by fracture, for example fracture of the scaphoid; by dislocation, for example dislocation of the lunate; by a combination of fracture and dislocation, for example fracture-dislocation of the astragalus; by operative intervention with stripping of soft tissues from the bone; or by embolism or thrombosis of end-arteries. The diagnosis was based essentially on the shadow of relative density. The possibility that there might sometimes be true increase in the density of dead bone was perhaps not yet finally excluded but in the vast majority of cases the density was no more than relative, and the appearances of true density were attributable to optical illusions. The pathology was that of complete bone death with osteoclastic resorption on one side of the lamellae and osteoblastic deposition on the other.

Clinical applications depended on three consequences of avascular necrosis: fragility of bone which unless protected became deformed; slow union of fractures when one fragment was avascular; and late development of arthritis due partly to the deformity of crushed joint surfaces but still more to death of the overlying articular cartilage. Deformity arising from the fragility of avascular bone could be seen in coxa plana when weight-bearing was permitted in the treatment of Perthes' disease; in crushing of the lunate bone in Kienbock's disease; and in flattening and crushing of the talus when weight was borne early after fracture-dislocation with necrosis of the body. Slow union due to avascular necrosis was obvious in certain fractures of the neck of the femur and fracture of the scaphoid. Even in fractures of the shaft of the tibia the relation of slow union to avascular necrosis could often be proved by radiographs taken at the right time. Late arthritis due to avascular necrosis was still the most important source of failure in the treatment of dislocation of the hip and fracture of the femoral neck. The incidence was higher than many believed—and no series of reported cases which claimed to indicate the frequency of this complication, and the possibility of reducing it by one or other device of treatment, should even be considered unless supported by at least five to ten years' follow-up of cases.

The relationship of avascular necrosis to Legg-Perthes' disease still presented problems for study. Examples were shown of avascular necrosis of the femoral head similar to those of Legg-Perthes' disease due to the trauma of dislocation of the hip and fracture of the femoral neck in children, and manipulative reduction of congenital dislocations; early tuberculous arthritis of the hip; osteomyelitis of the upper shaft and neck of femur; local foci of chronic bone infection in the femoral neck. In other words many types of injury and infection might cause thrombosis of the epiphyseal vessels with resulting avascular necrosis. Typical Legg-Perthes' disease of idiopathic type was no more than one example of avascular necrosis due to metaphyseal lesions which were sometimes, but by no means always, obvious in early radiographs.

Bone grafting was essentially a study in avascular necrosis. Sections of ordinary avascular bone necrosis due to injury, and sections of transplanted bone, were in all respects identical. Important clinical observations arose when it was recognised that complete replacement of dead bone in Perthes' disease of the hip took not less than two or three years. Complete replacement of a whole thickness bone graft also took two or three years. Cancellous chip grafting, with its apparently speedy bone formation, had led

investigators to believe that chip grafts did not die as whole thickness grafts did. In fact such grafts died in precisely the same way and this was proved by many sections. The only difference in their behaviour arose from the loose open-wove structure of the grafts with their thin lamellae. Primary union might be accelerated by chip grafting but final consolidation was no more rapid than after any other type of grafting. No matter how favourable the circumstances, adult bone could not grow and mature in less than three or four months, and even after cancellous chip grafting early application of shearing stresses could interfere with growth and cause non-union. The one certain indication for cancellous chip grafting and for rigid exclusion of any fragment of compact bone was a fracture with potential infection. In such cases there should be no foreign body of any type, neither screws, plates, nor dead compact bone.

" This is the Robert Jones Memorial Lecture and it is a great honour and distinction to be allowed to pay tribute in this city to one of the world's greatest pioneers of orthopaedic surgery—my chief, my teacher, my philosopher, and my friend. He handed on from Hugh Owen Thomas a tradition of scientific study. But it was not this alone which accounted for his contribution to the orthopaedic surgery of the world. It was not for this reason alone that we lament the destruction by bombs of 11 Nelson Street, Liverpool, a destruction which was quite complete except for the surgery door above which a stone was still visible, ' H. O. T. Surgery 1866.' Robert Jones knew the art as well as the science of surgery. This aspect of treatment, now known as rehabilitation, was his greatest contribution." L. M.

CORRESPONDENCE

Arthrodesis of the Ankle—Experiences with the Transfibular Approach—In the August, 1948, British issue of this Journal, an editorial footnote was appended to Mr J. Crawford Adams' article on " Arthrodesis of the Ankle Joint by the Transfibular Approach." We wrote: " To this day none of us knows with certainty who first conceived the brilliant idea of this simple and effective operation. Neither does any of us believe that it is important to attach the name of a single surgeon to a particular operation." So far, so good. But we went on to say that if credit must be attached it should be shared by certain young surgeons whose names were enumerated, and in so doing we regret very much that the important priority of Dr Thomas Horwitz of Indianapolis, Indiana, was overlooked. He writes: " Respecting your own thoroughness and the exactness of your British colleagues, several of whom were my dear friends in the Middle East in 1942–44, and appreciating the superb merit of your issues of the Journal, may I call your attention to: ' The Use of the Transfibular Approach in Arthrodesis of the Ankle Joint,' American Journal of Surgery, 1942, volume 55, page 550." We are grateful to you, Dr Horwitz, not simply because you have drawn our attention to your publication, but still more because in your article you indicated the gradual evolution of this principle from the work of Goldthwait in 1908, Gatallier in 1931, and Alldredge in 1940. The advance of science is on so broad a front that, no matter what branch is considered, progress can seldom be measured in terms of the contribution of any one individual. Almost invariably it is shared by many.

" Infections of the Hand "—In commenting on the article on " Infections of the Hand " by J. B. Loudon, J. D. Miniero, and J. C. Scott, published in the August number of the Journal (Vol. 30-B, No. 3, 409), Mr J. F. Curr, whose statistics were quoted, says that " a somewhat broad deduction has been made " when it was reported that his cases were treated with local and systemic penicillin. The fact is that many of his cases were treated without benefit of penicillin and in certain other respects the speed of recovery in his cases may have been somewhat under-estimated. It is uncertain that there has been any serious mis-statement of fact but we take satisfaction in the knowledge that Mr J. C. Scott and Mr J. F. Curr are now in correspondence with each other.

Death while Bathing—A correspondent to the columns of the British Medical Journal, Dr G. L. Alexander of Bristol, writes: " It would be interesting to know whether some unexpected deaths while bathing might not be due to acute prolapse of an intervertebral disc. About a year ago, in my bath, I was suddenly, as it seemed, cut nearly in two by something from behind. For ten minutes I lay in that bath paralysed and nearly fainting with pain. Had this happened while bathing alone in deep water I should certainly have died." The diagnostic significance of low back pain " of immobilising intensity " is of course well recognised but few of us have stopped to think of all the possible circumstances in which such immobilisation might occur.

ACKNOWLEDGMENTS

The British Journal is grateful to the Royal College of Surgeons of England for permission to reproduce oil paintings of Lister by W. H. Ouless, R.A.; John Hunter by Sir Joshua Reynolds, P.R.A.; and Hugh Owen Thomas by H. Fleury; and to the Derwen Cripples' Training College for permission to reproduce the portrait of Dame Agnes Hunt.

Book Reviews

TEXT-BOOK OF THE RHEUMATIC DISEASES. Edited by W. S. C. COPEMAN, *O.B.E.*, M.D., F.R.C.P., Physician to the Rheumatism Department and Lecturer in the Medical School, West London Hospital. Compiled by twenty-four contributors. 10×7½ in. Pp. viii+612, with 351 figures, some in full colour. Index. 1948. Edinburgh: E. & S. Livingstone, Ltd. Price 50/–.

Study of the rheumatic diseases is complex because it is not based upon one pathological process as in tuberculosis, nor upon a narrow regional distribution as in gynaecology. The feature which links all these diseases is social rather than clinical and comprises the element of crippling disability for which they have a high potentiality. While the disabilities are largely in the locomotor system this subject has ramifications far beyond the scope of orthopaedics. Examination of some of the titles in the present book will show how broadly based must be the vision of one who wishes to master the whole field, ranging as it does from Rheumatic Fever (Lord Horder) and Chorea (Copeman) to Rheumatoid Arthritis (L. S. P. Davidson), Osteoarthritis (T. E. D. Fletcher), Gout (Henry Cohen), Fibrositis (Copeman), and Sciatica (F. A. Elliott), not to mention some of the more rare arthritic syndromes. While, therefore, at least 50 per cent. of the work of an orthopaedic surgeon merits discussion under the term rheumatic disease, nevertheless, he should realise that the full scope of rheumatism requires consideration of every system of the body and the whole of pathology. In diagnosis and therapy no single person can encompass the subject. We are driven to the conclusion that no new specialism is required in the attack upon rheumatism. In fact there is here a lesson for medicine as a whole, as emphasized by Walshe: namely the need for integration, the development of team work, and a return to the viewpoint of the "physician."

The present work is a striking example of integration, for Dr Copeman, himself a distinguished physician, has gathered together a team of experts to present the many facets of his subject. He is to be congratulated on a review which is authoritative, in a way which no work by a single writer could equal. Of particular note are the masterly contributions by Henry Cohen upon the "Rarer Arthritic Syndromes" and "Gout"; each is written in characteristic style with perfect clarity and complete understanding. It is inevitable that in a series of thirty essays there should be some overlap of material and repetition of detail. This fault, however, is much less than in many similar works by multiple authors. Most of the articles are enriched by valuable lists of references. In this way Henry Cohen's essays provide models, as also do the excellent sections on History by W. S. C. Copeman, Anatomy and Physiology by D. V. Davies, Brachial Neuralgia by M. J. McArdle, and Special Pathology by H. J. Gibson. The orthopaedic sections by Watson-Jones and Osmond-Clarke are lacking in this regard. This is sad because in the space available they have not been able to deal exhaustively with this very large part of the therapeutics of rheumatic disease, and reference to the work of other authorities, some of whom they quote, would have been of help. These two sections, dealing respectively with the Principles and the Problems of Orthopaedic Treatment, are, however, as one would expect, first class and give a very fair outline of orthopaedic methods. One would perhaps have preferred a clearer exposition of joint posture in relation to function and physiological rest. The discriminating reader will not be influenced unduly by the tendency of the Watson-Jones school to regard arthrodesis of the hip joint as the "ideal" operation for unilateral osteo-arthritis, even in young people. Good as the operative result may be, it is a misuse of the word to call it "ideal." Nevertheless, these quibbles do not affect our appreciation of the excellence of this contribution.

Apart from those articles already mentioned there are contributions by Sir Adolphe Abrahams on Differential Diagnosis; C. W. Buckley on Spondylitis; H. A. Burt on Physical Therapy; Campbell Golding on Radiology; J. H. Kellgren on Pain; G. D. Kersley on Hydrotherapy; L. C. G. Pugh on Climatology; Oswald Savage on Dermatology; B. Schlesinger on Still's Disease; P. Stocks on Statistics; W. Tegner on Social Problems; Henry Wilson on Psychiatry; and B. W. Windeyer on Radiotherapy. In a work which deals with so much of general medicine it would be easy to find some little problem which has been omitted, yet it seems to us strange that practically no mention is made of the neoplastic conditions of synovial membrane nor any discussion of senile decalcifying spondylitis.

This new text-book will clearly for a long time be recognised as the standard British work upon the rheumatic diseases. In future editions, of which doubtless there will be many, we hope that a little pruning elsewhere will permit a rather more ample discussion of orthopaedic principles and practice. As it is, the work is a credit of distinction both to the publishers and to the notable team which Dr Copeman has assembled.—Norman CAPENER.

TREATMENT BY MANIPULATION IN GENERAL AND CONSULTING PRACTICE. By A. G. TIMBRELL FISHER, *M.C.*, M.B., F.R.C.S., Orthopaedic Surgeon to the St John Clinic and Institute of Physical Medicine and to the Arthritic Unit, St Stephen's Hospital. Fifth edition. 9×6 in. Pp. ix+275, with 126 figures. Index. 1948. London: H. K. Lewis & Co., Ltd. Price 25/–.

In the fifth edition of this manual Timbrell Fisher has added many new sections to the text and has made his ideas more easily understood by the addition of many new illustrations.

The first chapter deals with the history of manipulation in the treatment of joint injury and disease,

and it attempts to explain the reasons for remarkable changes in the opinions of surgeons as to its value. The author wisely states that destructive criticism of manipulative treatment is of little value, and that the subject must be taught from the basis of underlying pathology, a knowledge of which must form the basis of treatment. The outstanding feature of the work is the clarity of description of the type of injury, or the sequel of disease, which can be treated successfully by manipulation. Contra-indications are given clearly and the complications which may result from its unjustifiable use are stressed firmly.

Included in this excellent material, there are unfortunately some points to which exception might be taken. In the discussion on manipulation of joints the author suggests that an equally successful result can be obtained by manipulation whether the adhesions causing limitation of movement are intra-articular or extra-articular. Most of those who have experience with this method of treatment have found that the response to manipulation is much more satisfactory when adhesions are in the tissues round the joint and do not affect the joint lining or the articular surfaces. Again the author, in his discussion of low back pain and sciatica, wisely stresses the fact that surgeons must bear in mind the possibility that such pain may be due to retropulsion of the nucleus pulposus. Directly afterwards, however, he describes methods of manipulation and stretching of the sciatic nerve without indicating whether this method is to be used when retropulsion is deemed to be present. One other point might be noted; in the illustration of manipulation of stiff terminal interphalangeal finger joints, movement is being produced by the pressure of the surgeon's fingers on the nail of the affected finger. If this method is used to bend a really rigid terminal joint the result, as a rule, is the development of a haematoma under the patient's nail which renders subsequent physiotherapy impossible, thereby losing the movement gained.

This book can be studied with benefit by any surgeon who is interested in this branch of the work. Much can be learned from this sensible presentation of a subject which to most people is still a mystery.—T. P. McMURRAY.

HUMAN PHYSIOLOGY. By F. R. WINTON, M.A., M.D., D.Sc., Professor of Pharmacology, University College, London, and L. E. BAYLISS, Ph.D., Lecturer in Biophysics, University of Edinburgh. Third edition. $9\frac{1}{2} \times 6\frac{1}{2}$ in. Pp. xv+592, with 248 figures. Index. 1948. London: J. & A. Churchill, Ltd. Price 25/–.

In this edition, a number of physiologists have tried to co-operate in writing an elementary text-book in which the various branches of the subject would be presented to the student with the right emphasis. As a text-book of physiology the book is not entirely satisfactory because too much space has been devoted to the central nervous system and the special senses, and too little, for example, to the cardio-vascular system. The undergraduate is likely to gain an unbalanced view. The book may be useful to post-graduates who want to refresh their memory of the facts of elementary physiology without being able to spare time to read one of the large text-books. In this respect the usefulness of the book is limited by the omission of references to further reading.

The text is easy and, for the most part, clearly written; but some of the diagrams are unnecessarily complicated. An attempt has been made to present the subject from the point of view of human physiology and this has been fairly successful. Nevertheless, the book may not prove to be of great service to post-graduates.—John L. D'SILVA.

EARLY AMBULATION AND RELATED PROCEDURES IN SURGICAL MANAGEMENT. By Daniel J. LEITHAUSER, M.D., F.A.C.S., Chief of Surgery, St Joseph Mercy Hospital, Detroit, Michigan. $9\frac{1}{2} \times 6\frac{1}{2}$ in. Pp. xi+232, with 36 figures. Index. 1947. Oxford: Blackwell Scientific Publications, Ltd. Price 25/–.

The purpose of this monograph is to impress upon surgeons the importance of early walking after abdominal operations. From an experience of more than 2000 patients the author asserts that if correct surgical procedures have been employed, early walking is entirely without danger; it reduces the incidence of pulmonary atelectasis and thrombo-phlebitis, shortens the period of stay in hospital, and diminishes post-operative disability.

It is recommended that as soon as the patient recovers from the anaesthetic (about three hours after operation) he is carefully assisted out of bed, made to cough in the standing position, and encouraged to walk round the bed. It is emphasized repeatedly that coughing is more valuable when the patient is standing than when he is sitting or lying. In cases of incipient atelectasis it is usually possible to detect "palpable rales" at the pulmonary bases when the patient stands; after a bout of coughing a plug of mucus is expelled and the rales disappear. Whenever atelectasis is suspected, coughing in the standing position is repeated at two-hourly intervals. The only contra-indications to early walking are severe shock and a large mid-line vertical scar. Continuous intra-abdominal suction is not a contra-indication; in fact, after

cholecystectomy, the author gives continuous suction and disconnects the nasal tube from the suction apparatus when the patient gets out of bed. Types of incision and the nature of suture material are discussed. Transverse or oblique incisions are generally recommended. Mid-line and particularly mid-rectus incisions are believed to predispose to wound disruption and post-operative hernia. Fine chromic catgut is used for the peritoneum and extra-peritoneal fascia, and alloy steel wire for other layers and the skin.

The average length of stay of patients in hospital after operation was: appendicectomy (795 cases) 2·26 days; cholecystectomy (180 cases) 7·4 days; repair of hernia (200 cases) 5·7 days; pelvic operations (176 cases) 6·3 days. In a series of 2700 cases there were only fourteen fatalities, in none of which could death be attributed to early walking. Incipient pulmonary atelectasis occurred in four cases, post-operative pneumonia in two, and thrombo-phlebitis in two. Disruption of the abdominal wound did not occur. Twelve hernias recurred.

The author puts up a good case for early walking. Nevertheless, in anxiety to drive his points home, he tends to lecture the reader. There is a good deal of repetition even to the extent of allowing the same sentence to appear in consecutive paragraphs. The book is well produced and well illustrated.—H. A. BURT.

TEXT-BOOK OF ANAESTHETICS. By R. J. MINNITT, M.D. (Liverpool), D.A. (R.C.P. & S., Eng.), Senior Honorary Anaesthetist, Royal Liverpool United Hospital, Liverpool Maternity Hospital, and Birkenhead Maternity Hospital; Director of Anaesthetics, David Lewis Northern Hospital, Liverpool, and John GILLIES, *M.C.*, M.B., Ch.B. (Edin.), F.R.C.S. (Edin.), D.A. (Eng.), J. Y. Simpson Lecturer in Anaesthetics, The University of Edinburgh; Director, Department of Anaesthetics, Edinburgh Royal Infirmary; Consultant in Anaesthetics, Department of Health for Scotland. Seventh edition. 9×6½ in. Pp. vii+568, with 229 figures. Index. 1948. Edinburgh: E. & S. Livingstone, Ltd. Price 30/–.

The seventh edition of "Minnitt and Gillies" will be welcomed warmly by all who teach anaesthesia because the previous edition, which has been out of print for some time, was unquestionably the best text-book for undergraduates extant in this country. The new version is much enlarged—568 pages as against 487, and with 229 illustrations instead of 199. The figures are clear and well chosen, some being in colour.

There is no need to make detailed reference to the teaching which is sound throughout. It has been brought up to date by a chapter on the use of curare by Dr T. C. Gray. The section on local analgesia by Mr L. B. Wevill has been extended and it is now of much use as a practical guide in technique, as also is the subsection devoted to applications in dentistry by Professor John Boyes. Some of the legal aspects of anaesthesia have been dealt with by J. Crossley Vaines who is a Master of Law.

A few minor criticisms might be made. Abbreviations are not always those which are officially recognised; for example "gm." for "g." and "c.c." for "c.cm." Moreover, the nomenclature is not uniform; the term millilitres is sometimes substituted for cubic centimetres. The only technical advice which is open to criticism is that which relates to the administration of strychnine in cocaine poisoning. The literary style is usually excellent, and the book can be recommended whole-heartedly as a sound basic guide. The paper, printing, and binding are well up to the high standard which is now expected of Messrs E. & S. Livingstone, Ltd.—C. Langton HEWER.

NOTES ON THE NEUROSURGICAL NEEDS OF THE POPULATION AND THE TRAINING OF THE NEUROSURGEON. 5½×8½ in. Pp. 34. Published by the Society of British Neurological Surgeons.

The last war brought a striking increase in the number of beds available for neurosurgery. The planning committee of the Society of British Neurological Surgeons (Sir Hugh Cairns, President) now suggests the provision of one neurosurgical centre of fifty to sixty beds per million inhabitants, most usefully situated in close proximity to a university and teaching hospital. Country hospitals are good only for convalescence or chronic maladies requiring little medical care. It is improbable that the number of neurosurgical beds in a thousand-bedded teaching hospital could exceed forty. The committee, however, is convinced that neurosurgery is a proper subject for the clinical training of students because it furnishes admirable lessons in applied physiology. Much that is wise as well as stimulating is contained in the recommendations on the necessary qualifications and training of the neurosurgeon. The creation of a special Diploma in Neurosurgery is felt to be undesirable. The report stresses the close relationship between neurological surgery and other branches of medicine and surgery. Orthopaedic surgeons, in particular, will derive considerable information and mental stimulation from its study. It is interesting to note, for example, that in an analysis of 32,491 admissions to fourteen centres between 1940 and 1945 there were 2627 cases of sciatica and 795 spinal tumours.—W. R. BETT.

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